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The Present Extent of Plant Protection Measures

(Surveys in the sub-area Giessen of the Plant Protection Office
for Hessen-Nassau)

By Dr. M. Hanf
(20 Illustrations)

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A. Losses Caused by Plant Infestation Call for Intensified Protection

Morstatt worked out a detailed calculation approximately 20 years ago of the losses suffered annually by German agriculture as a result of plant diseases and parasitic infestation. The figures he arrived at, namely

- 10.8 % losses due to diseases and
- 7.8 % losses caused by animal parasites,

have been frequently quoted in the meantime. These immense values which amount to 2,000 millions with respect to the former German Reich and to approx. 700 millions for the Federal Republic (in fact far more according to the current agricultural prices), have been referred to again and again both verbally and in writing. The urgency of the matter is expressed in the words of Federal Minister Dr. Niklas in his introduction to the instructional bulletin of Dr. Drees (3) on "Pflanzenkrankheiten und landwirtschaftliche Erzeugungssteigerung" (plant diseases and increase in agricultural production):

"All plans drawn up for agricultural production are incomplete so long as we remain unsuccessful in protecting the growth of plants and the harvest yields from diseases and parasites. The losses have assumed unbearable proportions and, in view of this, greater significance must be attached to plant protection measures in order to safeguard and improve the nation's larder".

The above-mentioned bulletin quotes a number of very informative examples which illustrate the insupportable volume of the losses.

The following sentences contribute further to this subject:

"A second necessity which appears to me to stand out in the development of cultivation would be to promote and continue the extension of plant pathology on a broader basis than has previously been the case. The fact that the susceptibility of the organisms, whether it be human beings, animals or plants, increases with the progress of the cultural status is something which experience has taught us and which we can observe by just casting a glance around us. The increase in damage inflicted upon our cultivations by plant and animal parasites, therefore, is not a contingency but a phenomenon brought about by nature in accompaniment with the advancement of culture. We shall have to anticipate, therefore, a further intensification of these losses in national property in the future. According to this it would be time to take the necessary protective measures which in this case would consist of setting up plant pathological institutes each with a botanical and zoological department, wherever these do not yet exist, at all higher research and training centres for agriculture, forestry and horticulture. This step would put as many workers as possible on the trail of the rapidly growing army of parasites by enabling them to study the development and control of the latter. Furthermore tuition and explanation given by experts of these three branches of production would eliminate the helplessness which to a large extent is prevalent at the present day. Countries abroad have already considerably outstripped us even in this field, and anyone familiar with these conditions must consider it uneconomical to save a few thousands in equipment and at the same time to allow millions to be lost annually due to crop destruction which in turn means losses in national property and in taxes which would have been otherwise raised from crop production."

In continuation:

"It is essential that plant pathology be allocated a large number of appropriately staffed and equipped institutes spread throughout the country, because experience has shown that with the advancement of cultivation there is an increase in the number of fungal diseases and animal parasites on plants. The country is already suffering such heavy losses due to the steady increase in these damages that apparently the expenditure now required for prevention and control cannot be delayed any longer without agriculture, forestry, horticulture and also the state being at a disadvantage. Furthermore the execution of these tasks promises a rich interest."

These words are just as applicable today as they have been in the past. Have we not also spoken of an increase in damage? Do we not also require an extensive plant protection service and a better training for both phytopathologists and field workers? And yet it is almost 40 years since Prof. Dr. von R ü m k e r said this during the "Verhandlungen des Königlichen Landes-Oekonomie-Kollegiums" in Berlin in February 1913 (32).

The demands have remained the same although we know that in this new field of phytopathology very much has happened during the past 40 years. We appear, however, to be still a long way from our aim. About 20 years later we read the following sentences in the excellent publication by M a m m e n (1936, 19) on "Die wirtschaftliche Bedeutung des Pflanzenschutzes und Vorschläge zu seiner weiteren Ausgestaltung" (The economic significance of plant protection and proposals for its further development):

"Plant protection has today proved the justification of its existence. Following determined research work success has been achieved in discovering either control measures against many dangerous diseases and parasites or remedies on the road to making the plant immune against these diseases. In those cases where the results of research are not yet available to field workers and where control is not yet being carried out to the required extent, this may be attributed to the organization of the Plant Protection Service which even today is still completely insufficient and whose task it is to place these research results at the disposal of the field workers."

Basically these ideas are the same as those expressed in 1913. When we once again refer to the above-mentioned publication of Drees, we read the following:

"The intention of this publication is to discuss the possibilities of reducing harvest losses and to show the public what significance should be attached to the control measures to be taken against plant diseases and parasites. In addition, however, it is also intended to serve as an appeal so that — as is already usual abroad — the necessary understanding will be shown for the plant protection service — be it on a scientific or practical basis — to enable it to solve its important tasks satisfactorily within the framework of the production economy."

We are still not in a position to solve these problems, and it would appear that the lead held by neighbouring countries, mentioned in 1913, has not yet been caught up with. The demand for intensified protection still exists. Although the above citations originating from various periods sound very much the same, a change has actually taken place. The plant protection service has been extended. But at the same time plant cultivation was intensified whereby the demands for protective measures grew, thus necessitating a further extension. The more intensively soil utilization is pursued, the more losses resulting from plant infestation will be felt (see U n t e r s t e n h ö f e r, 31). A short survey shall show what has been carried out, but at the same time point out the way which still remains for us to take.

Since 1868, more than 80 years ago, when Medizinalrat F u c h s demanded the employment of plant doctors during a speech he made in Karlsruhe and thus for the first time pointed out that not only human beings and animals but also plants require medical attention, the road has been paved for a large-scale development. Very much never before dreamt of in the field of plant protection, particularly following the foundation of the "Biologische Reichsanstalt" in 1898, has been carried out, but nevertheless there is still an immense amount of work to be done. The plant protection experts are today acquainted with the biology and the control possibilities of a very large number of parasites and diseases, but in most cases those employed in agriculture are not aware of these facts. Prof. Dr. A p p e l (1), the earliest pioneer in the German Plant Protection Service, repeated emphatically in 1947: "What we require is a plant doctor!" Only when there are enough well-trained specialists will any success be attained in combating all plant infestations effectively.

Two years later E x t (33) made the following demand: "We require efficient plant protection technicians!" A bridge must be spanned to link up research work and work carried out in the field.

"There is no doubt whatsoever that a yawning gap exists between what has been investigated and proved during past decades and what has been actually introduced in the practical field. In my opinion, this is the reason why we are repeatedly encountering such heavy losses, thus decreasing our harvest yields in many cases and impairing the crops."

Central offices for plant protection were set up in all the lands of Germany in 1891 — known since 1933 as the Plant Protection Offices — and their first task was to sort out the huge amount of material available on the parasites and to clarify the individual questions of control. At first these data were not at the disposal of those working in the field. The first attempt to carry out uniform control measures over large areas was made in 1936. 25 young people who had taken degrees in biology and agricultural sciences were summoned to G u h r a u for a short period of tuition in order to be trained for the subsequent large-scale campaign against the *Piesma quadrata* all over the eastern parts of Germany. For the first time a uniform control of a parasite was carried out extensively on all fields, either by careful instruction of the farmers or, when necessary, by

coercive measures. The success obtained justified the measures continuously applied over several years. The same year witnessed the start of a campaign against the potato beetle, which was followed up by the foundation of an organization known as "KAD" (Kartoffelkäferabwehrdienst = Potato Beetle Control Service). This organization with technicians stationed in each district is today rendering great service to plant protection as a whole.

The sole aim of the district offices for plant protection, first opened in Hesse and Pommerania in 1937, was to be put into practice on the broadest possible basis all knowledge gained in research work. The experiences gained and success achieved in this direction were of such a satisfactory nature that an attempt was made to tighten the net of district offices in all lands. The outstanding factor which repeatedly came to the forefront was that comprehensive measures in the plant protection field may only be carried out successfully provided they are planned and supervised by experts. Due to the fact that they had so many other matters to attend to, the remaining agricultural offices had not the time to devote themselves as intensively as necessary to these tasks which above all require special knowledge.

Even the district offices and plant protection technicians will not be completely successful in their work until they are supported by specially trained personnel in each district, in which case it will be necessary to comply with the demand for a "Pflanzenschutzwart" (plant protection warden). The numerous proposals made to solve this problem are of a varied nature but the final aim remains the same, namely, control of plant infestations down to the last hamlet and the last farm. The most varied publications on this question have appeared during the past few years. We would mention the publication of Heller (14), "Das ganze Dorf muß helfen" (The whole village must assist), in which reference is made to the plant protection warden as the organizer of community work. Furthermore there is the idea of Erdmann (5), who regards the plant protection farm as an undertaking equipped more on industrial lines with the necessary equipment and personnel available for general control work to be carried out at short notice. The "Neue Mitteilungen für die Landwirtschaft" (34) includes an article proposing that local parasite control services be set up, together with the reply of Hanf (9) and the opinions of two farmers (35). It is these two opinions in particular which elucidate the various conceptions. The one point of view suggests that the farmer should use his own initiative and that the best and cheapest method is to carry out control at the right time by employing the farm's own personnel for this purpose, whereas in the other opinion the attitude is adopted that it is far more preferable to engage the local parasite controller who saves the farmer a large amount of work and that the farmer would be willing to spend a few marks for this purpose. But it is this "payment" which seems to create the main difficulty, because many farmers have not yet recognized the advantages of incurring additional expenditure for plant protection. The farmers prefer the local specialist who is not employed full time, but who is more or less at the community's disposal on a free-lance basis. All publications are unanimous in stating that complete success in pest control is only to be expected when suitable personnel are stationed in the village to realize the endeavours of the phytopathological service.

Just how far this scientific knowledge has actually been put into practice and to what extent the farmers follow the advice and reminders of the phytopathological service will be illustrated in this paper by giving details of investigations made to determine to what extent several plant protection measures

appearing to be particularly important were actually taken in a small operational area comprising 10 rural districts. It is not claimed that investigations apply in the same manner to all districts in Germany, although in many respects there is a similarity to agricultural conditions prevalent in other parts of Germany and probably they will provide suggestions for similar investigations which, with a view to the further development of plant protection, appear necessary. Approximately one fifth of the crops gathered in from our fields is lost annually. The object of this paper is to discuss whether we are in a position, with the present measures taken in agriculture as a whole, to decrease these losses to a considerable extent and to discover what possibilities exist to further intensify plant protection.

B. The Most Urgent Plant Protection Measures and their Economic Significance

Many hundred species of fungi and bacteria as well as hundreds of insect species are to be found annually at work on the cultivated plants and it is these that are the cause of the enormous losses referred to in the first chapter to be dealt with in detail in this paper. It is not possible to completely control all these infestations each year and in fact it is not even necessary. Only a small percentage of all these various types of diseases and noxious insects appear at such regular intervals that an annual control is necessitated. In many cases one has to wait and can even afford to wait until the first signs of an attack appear. Against other species, however, control measures have to be taken each year and as far as possible on every field if regular yield losses are to be avoided, whereas there are also cases where preventative measures have to be taken to prevent early infestation (*Phytophthora*, *Peronospora*, *Fusicladium*).

Naturally it is difficult to say which are the most important diseases from an economical point of view because this varies from district to district. The most important diseases and pests in viniculture areas are those to be found on the vine, those in the hop growing districts are the ones found on the hops and in fruit growing districts the most important are those diseases and parasites present on fruit trees. Before a list of the most important economical control measures can be drawn up, a knowledge of the agricultural structure of the district concerned is an essential prerequisite.

The area in which the volume of several plant protection measures was investigated comprises 10 rural districts with 784 parishes and a total of 153,000 hectares of arable land. Small farms are a characteristic of this area situated on the northern and eastern belt of the fertile Wetterau with the central Lahn valley and the hilly country stretching from Vogelsberg to Westerwald. 45—54 % of all farms in the individual rural districts cultivate less than 0.5 hectare of arable land; approx. 20 % cultivate 0.5—2 hectares; a further 20 % work some 2—5 hectares and only 10 % are larger farms with 5—20 hectares of agricultural acreage, whereas there is only 1 % of large farms with more than 20 hectares. The predominance of small-holdings is to be attributed to the fact that many owners are employed in industry and often leave the cultivation of the fields to their families. An understanding for additional plant protection measures is seldom found among these people, but the area cultivated by the small-holder plays an important part in the total economy. In addition to this there is the large-scale splitting up of ownership; there is many a farm with 3 or 4 hectares where there are dozens of small plots to be managed. The arable

land of farms with 15—20 ha is often divided into 300—400 and more very small plots caused by the practice followed for generations of inheriting portions of all the fields. To quote only one example, reference is made by Streuer (27), in the publication "Flurbereinigung" (redistribution of land), to a farm 23.9 hectares large located in Kreis Wetzlar and which is divided into 645 plots; this means that one field has an average area of 370 sq. metres, mostly one hundred or more metres long but only several metres in width with the result that the working width of a normal horse-drawn spray cannot be utilized. Even that is essential for the introduction of plant protection measures. On the whole, however, the agricultural structure of the area is extremely variable so that interesting comparisons may be made. In many parts of western and south-western Germany there are similar ownership conditions so that many parallels to the findings arrived at here may be found in those districts.

It is not only the size of the farm but also to a greater extent the various types of cultivated produce that play a part in the selection of important plant protection measures. The distribution of the main types of crops is given in Table 1 (according to survey of soil utilization 1950).

Table 1: Cultivation of the main crops
(districts tabulated)

District	Agricultural condition	Agricultural acreage in hectares	Field area in hectares	Winter cereals		
				Rye	Wheat	Barley
1. Biedenkopf	Predominantly hilly. Very small farms with small fields on sloping grounds. Influence of the industry.	16,639	9,562	26.7	6.8	0.0
2. Schlüchtern		22,595	9,581	22.6	9.5	0.0
3. Dillkreis		21,380	7,857	22.0	9.3	0.0
4. Lauterbach		31,493	14,391	21.8	8.2	0.0
5. Gelnhausen	Partly hilly. Single parts (e. g. river valleys) with favourable cultivation conditions. Partly large farms.	24,021	12,642	21.4	10.0	0.0
6. Wetzlar		28,201	17,796	20.0	9.7	0.0
7. Alsfeld		37,973	20,141	20.0	13.0	0.0
8. Oberlahn		19,835	13,808	15.0	13.0	0.0
9. Giessen	At the edge of the Wetterau with favourable cultivation conditions: large and purely agricultural parishes.	38,636	24,865	13.1	15.5	1.0
10. Büdingen		39,645	22,308	11.5	17.8	1.0
		280,418	152,951			

The districts in Table 1 have been listed according to the acreage area of the rye fields. Where there are smaller areas of rye fields, the acreage used for winter wheat and root crops, particularly sugar beet, naturally increases. At the same time this arrangement produces a certain "order of precedence" of the districts with respect to the favourable and unfavourable agricultural conditions generally prevalent. The first four districts (Biedenkopf, Schlüchtern, Dill and Lauterbach) consist of hilly country with poor quality soil. The proportion of these conditions decreases in the other districts more or less in accordance with the order in which they are placed whereas the more favourable conditions increase. Large parts of the districts of Büdingen and Giessen belong to Wetterau and parts of the Oberlahn district to the fertile "Limburg basin", the "Golden Ground". These data are only intended as guiding principles to what is later discussed and are not to be regarded as absolutely applicable with respect to the above-mentioned "order of precedence" in view of the fact that only one point, namely rye acreage, has been considered. A more exact examination of other factors (soil, farm conditions, altitude etc.) may cause a re-arrangement of the

Important field crops in % of field area
(according to the size of the rye area)

Districts	Spring cereals		Potatoes	Beets		Rape Turnips	Remainder	Fruit trees (as per count 1951)	
	Barley	Wheat		Sugar beet	Fodder beet			Total number	Number per hectare of agricultural acreage
22.4	2.8	—	20.4	0.1	9.0	0.6	11.0	208,482	12
6.8	6.7	0.2	14.9	0.2	10.8	1.7	16.1	178,695	8
20.0	2.3	0.1	24.2	0.1	8.5	1.0	12.3	312,000	14
20.8	9.4	0.1	14.8	0.1	10.7	1.0	12.6	96,267	3
6.0	5.5	0.2	17.6	0.3	12.8	1.3	14.4	276,932	11
11.7	1.7	—	17.8	0.2	11.9	0.4	16.1	309,900	10
20.0	7.8	—	14.2	0.2	10.9	1.1	12.4	175,317	5
20.1	6.2	—	15.6	0.2	10.3	0.2	19.1	200,421	10
6.2	7.5	0.3	16.0	1.4	11.5	0.7	16.4	332,487	7
5.1	2.3	0.3	16.2	2.6	12.3	1.1	13.5	305,908	8
								2,396,409	

"order of precedence". This, however, would have no bearing on the subject under discussion.

Field vegetable cultivation and other special cultures hardly play any part whatsoever. Fruit growing, on the other hand, as seen from Table 1, is of really great importance at least in the parishes around the Wetterau. Altogether more than two million fruit trees, chiefly apples and damsons, grow in the area. In many parishes, in which 10,000 to 20,000 trees are often to be found, these are the major source of the total income derived from agriculture. The general care given to these trees, however, still leaves much to be desired and as a whole the economic value of intensive fruit growing has not yet been recognized.

Based on the described agricultural structure we are able to mention ten plant protection measures in an approximate temporal sequence as being particularly important and of great economic significance. These are:

1. Dressing of all cereals;
2. Weed control, especially in spring cereals;
3. Pollen beetle control;
4. Potato beetle control;
5. Late blight control;
6. Control of potato virus diseases;
7. Summer spraying of fruit trees, especially control of scab and codling moth (at least one pre-blossom and one post-blossom spray);
8. Grain weevil control;
9. Dormant spraying of fruit trees;
10. Control of rats and mice on farms and fields.

Ten measures — a small part really of all that should be carried out. But how much of that is actually done? We shall refer to that later. At first it is important to throw some light on the economic significance of these ten measures. For this purpose it is intended to make use of our own observations made in the area and above all the known losses repeatedly mentioned in literature.

1. Seed Dressing

It is really difficult even to make an approximate assessment of the losses resulting from diseases which are controlled by dressing. Mould, stinking smut in wheat, leaf stripe and loose smut in oats as the most important diseases still occur quite frequently although the significance of these diseases may have receded somewhat since dressing was introduced on a large scale.

Mammen (19) states that between 1929 and 1934 the percentage of area infested by leaf stripe (*Helminthosporium gramineum*) amounted to 44.1—75.7. There are no exact figures available on the extent of the losses incurred. Numerous fields infested by leaf stripe have been found in the local area during the past few years. Yield evaluations following dressing tests are unfortunately not available.

Even stinking smut (*Tilletia tritici*) has begun to propagate again. Numerous samples have been obtained which were coloured black by *Tilletia* spores. In this case we have not only to contend with the direct losses of the smutted ears

but also with those losses occurring due to the uselessness of the blackened harvest (Photo 1).

On a large farm in Biedenkopf the whole wheat crop could not be used for making bread because the dressing had not been carried out due to a "lack of time" with the result that the crop was coloured by *Tilletia* spores to such an extent that it looked as if soot had been emptied over it. Percentages of smutted ears arrived at in tests cannot be used to determine the general losses.



Photo 1. Increase in stinking smut in wheat and loose smut in oats. Both may be avoided by dressing.

Among the diseases referred to, loose smut in oats (*Ustilago avenae*) is the most widely spread in this area. Smutted panicles were counted in numerous oat fields and it was found that up to 20 % of the crop had been infested. A large number of fields on the other hand were free from infestation, which means that, in this instance as well, it is very difficult to arrive at an average value. The heavy infestation of loose smut in oats may be attributed to the fact that in many cases the oats are not dressed at all (see Section C) or, what is more often the case, the farmers forget to increase the concentration of seed steep. This occurs because mostly the dressing apparatus is in regular use and, whereas the normal quantity for other varieties of grain amounts to 200 g / 100 kg, 300 g should be used when dressing oats. In consequence a negative result is obtained, so that the farmer loses all interest and does not bother to repeat the dressing the following year.

Even though it is not possible to compile exact figures on damages which could occur due to a failure to dress the cereals or where dressing has been carried out carelessly, general estimations can be made on the possible losses in the area. According to information given by the Hess. Statistisches Landesamt (21), the 1950 grain harvest in Hesse amounted to an average of 2,500 kg per hectare. This means that a harvest of

about 215,000 metric tons of all varieties of grains

is produced on a grain growing area of 85,779 hectares in the districts dealt with here. Assuming that only 1 % is lost, namely only every hundredth plant is damaged which is an extremely low figure, this would mean a loss of approx. 2,000 metric tons or, when expressed in money, a loss of approx. DM 800,000. If all cultivated grains were dressed (with an average of 150 kg/hectare approx. 13,000 metric tons) we would require approx. 30,000 kg of seed steepers annually (calculated on "dry seed dressing" including the additional quantities for oats). This quantity of seed steepers corresponds to a value of some 112,500 DM (assuming an average price of DM 3.75 per kg). The costs will by no means amount to the assumed 1 % losses. The expenditure actually incurred for the dressing will be referred to later in this paper.

The official reports on the occurrence of plant diseases show that the diseases to be controlled by dressing have by no means died out (see Table 2). The assumption of 1 % damage may be regarded as extremely low.

Damage amounting to 5—10 % caused by smut diseases, mould and leaf stripe could most certainly be assumed, were the seed dressing not carried out at all. Seed recognition by authorities, seed cleaning and seed rotation also contribute to decreasing the danger of losses. If 5 % of the crop were damaged by such diseases, the harvest loss would amount to 4.3 millions, which to a greater part is today avoided.

Table 2: Occurrence of grain diseases which can be controlled by dressing

(1 = none, 2 = weak, 3 = moderate occurrence throughout the rural district)

District	Mould in Rye			Leaf Stripe in Barley			Stinking Smut in Wheat			Loose Smut in Oats		
	1949	1950	1951	1949	1950	1951	1949	1950	1951	1949	1950	1951
1—4	—	1—2	1 2	2	1—3	2	1 2 2	2		2	1 3	1 2
5 8		1 2	1 3	2 3	1—3	1 3	1 2 1 2	2		1 2	1 3	1 3
9 and 10	—	1 2	1	2	1 2	1 3	1 2		1 2	2—3	1 3	1 3

2. Weed Control

Apart from the application of certain chemical agents, there are many other methods at the disposal of the farmer for the control of weeds. We would only mention the timely application of the harrow and calcium cyanamide. Without doubt the weed invasion of the fields has receded considerably during the course of the last 10—15 years following improved and better planned cultivation measures, but in spite of this the "beauty" of vividly coloured fields full of yellow wild radish and wild mustard, red poppies and blue cornflowers together

with the many inconspicuous types of flowers has not disappeared in any way whatsoever. There is no doubt that these colours are, for the layman, worthy of admiration in that they enliven the green cultivation areas, but on the other hand they represent enormous damage for the crop yields. This damage may only be recognized by comparing crops free of weeds and those infested by weeds.

According to data collected by K o r s m o (16, page 545 and following) and M a m m e n (19, page 33), it has been established from all their investigations that a loss of approx. 20—25 % following heavy weed invasion may be expected. In his investigations K o r s m o found that the crop yield increases as the number of weed plants decreases. This is not surprising when it is considered that the extraction of nutritive substance per hectare with a weed invasion of only 46 wild radishes amounts to

approx. 43 kg pure nitrogen
„ 16 kg pure phosphoric acid
„ 43 kg pure potash
„ 41 kg lime.

This means that the farmer must use the following quantities of fertilizer in order to compensate for the losses:

200 kg of 20 % nitrogenous fertilizer*
100 kg of 16 % phosphate fertilizer
100 kg of 40 % potash fertilizer
50 kg of caustic lime.

He has, therefore, to spend approx. DM 100 per hectare on these quantities of fertilizers in order to "feed" the weeds on his fields. The nutritive substance taken away by the weeds is a disadvantage to the crops thus leading to the high losses in grain of more than 20 % followed by the correspondingly low straw crop.

The fact that the number of 46 weeds per sq. m. taken as a basis above is to be regarded as extremely low is shown in the results of several of our own evaluations. 47,000 young poppy seedlings were counted in spring on each sq. m. of a wheat field near Giessen (see H a n f, 6). The counts of wild mustard on a test field in Oberlahnkreis may be mentioned as a further example to show the degree of infestation. 1,035 weed plants per sq. m. were counted on this field, and on the same area there were 340 oat plants (see H a n f, 13). It is therefore not surprising that the oats, outnumbered threefold by the weeds, were not able to flourish, especially when considering that the weeds were consuming a very much larger quantity of nutritive substance. Most of the weeds die off during the course of development due to the fact that the plants are competing with each other for nutrition, but just the same a yellow or red blossoming area still remains.

As already mentioned, the results of K o r s m o's experimental work show a 21 % decrease in crop yield as a result of more or less heavy weed infestation. This figure was arrived at approx. 30 years ago as the average of 3552 experiments. Our own tests have shown that the same losses are to be anticipated even

* Figures obtained in accordance with an instruction of the Süddeutsche Kalkstickstoff-Werke A.G., Trostberg (Oberbayern) on the use of calcium cyanamide in weed control.

today. The following table 3 provides information on the crop values of 12 of these tests which were arranged to demonstrate the effect of new control agents (Photo 2).

Although the individual weights were not taken into consideration it was possible to recognize the same effects from purely outward appearances in some 50 further tests.

We are able to gather the same from other areas as well. Stummeyer (28, pages 30 and 32) reports the following as the average of 139 tests spread out over the whole of the Federal Republic:

winter rye:	a yield increase from 28.6 to 33.8 = 520 kg
winter wheat:	” ” ” 31.2 to 37.3 = 610 kg
spring cereals:	” ” ” 26.6 to 32.5 = 590 kg

On the average this represents a yield decrease caused by weed infestation amounting to approx. 15.4 to 18.1 %. On comparing the following values for yield decrease

Korsmo	21.0
Hanf	19.4
Stummeyer	16.6

Table 3: Demonstrations on weed control 1950/51

Location	Grain type	Yield 100 kg/hectare			Yield decrease in % caused by weed invasion
		untreated	sprayed	increase	
Bottenhorn	Oats	11.5	23.0	+ 11.5	50.0
Friedensdorf	Oats	14.6	24.3	+ 9.7	39.9
Bottenhorn	Oats	16.4	20.8	+ 4.4	21.2
Treis/Lumda	Barley	18.0	34.0	+ 16.0	47.0
Buchenau	Oats	19.4	23.0	+ 3.6	15.6
Steinbach	Barley	23.0	29.5	+ 6.5	22.0
Amdorf	Oats	25.5	31.7	+ 6.2	19.5
Odersberg	Oats	25.5	28.3	+ 2.8	9.9
Hof Güll	Wheat	30.7	34.3	+ 3.6	10.5
Amdorf	Oats	32.5	35.0	+ 2.5	7.1
Münchholzhausen	Oats	35.0	36.6	+ 1.6	4.4
Londorf	Oats	36.8	37.8	+ 1.0	2.6
Average =		24.1	29.9	5.8	19.4

more or less the same picture is produced despite the various areas. We should therefore not be mistaken when anticipating yield losses in grain alone of approx. 20 % on weed-infested grain fields. For a grain growing area of 85,779 hectares and an average yield of 2,500 kg per hectare, a yield loss of 20 % represents a loss of 43,000 metric tons or DM 17.2 mill. if no weed control had been carried out.

In order to approach the actual total damage in an area it is essential to know the degree of weed infestation. For this purpose, however, there are hardly any data available and are in fact difficult to obtain. Mammén (19, page 35) quotes, in accordance with the annual reports on pest invasions in Germany from 1929 to 1932, an average medium to very heavy weed infestation of 44.8 to 67.4 %. An inquiry carried out in 1950 by the agricultural schools in the local service area and covering all of the 784 parishes showed that approx. 40 % of all summer grain fields suffer from medium heavy to heavy weed infestation. For the purpose of this inquiry the degree of infestation caused by wild radish and wild mustard was estimated separately for each parish. We may assume without any hesitation the same degree of infestation for winter cereals (in this case the weeds concerned are chiefly cornflowers, poppies, penny cress, corn grass). Taking the above-mentioned results as a basis we can, on the average, reckon with a possible yield increase of 600 kg/hectare following intensive weed control.



Photo 2. Weed test in Bottenhorn. Left: treated section — oats 120 cm high without weeds, harvest 2300 kg/hectare. Right: untreated — oats 90 cm high, 60 % weed, harvest 1150 kg/hectare.

This means in the case of a grain growing area of 85,779 hectares, when the weeds are sufficiently well controlled, that 20,587 metric tons more could be harvested on 40 %, i. e. 34,312 hectares, of the total area. Unfortunately this is not the case, with the result that in the local districts agriculture suffers an annual yield loss amounting to approx. DM 8 million (at DM 40 per 100 kg). These figures do not include straw losses and all the other consequences accompanying heavy weed infestation. In view of these calculations it is not surprising when R o e - m e r (according to M a m m e n, 19, page 33) assesses the pre-war damages caused by weed infestation at RM 600 million for Germany as a whole.

What would weed control on all grain fields cost if we were to assume an overall treatment with chemical agents? We can anticipate an expenditure of DM 30 per hectare including wages, agents etc. This, therefore, represents a necessary expenditure of DM 1,029,360, which after all only amounts to one eighth of the expected profit.

The fact that the assessed value of 40 % weed-infested fields is not too high is confirmed by reports which quote in most cases figures 3 and 4, in other words a medium to heavy infestation of weeds, for the areas under observation (see Table 4).

Table 4: Reports on the weed infestation of grain fields and the appearance of the pollen beetle.

District	Weed infestation			Pollen beetle		
	1949	1950	1951	1949	1950	1951
1— 4	2—5	2—4	3	1—3	1—3	2—4
5 8	3—4	2 4	2—4	1—3	2—4	2 4
9 and 10	3	2 5	2 4	2—4	2—4	1—3

3. Pollen Beetle

The damage that is inflicted by the pollen beetle (*Meligethes aeneus*), especially on winter rape and winter turnips, is sufficiently well known and really does not require any further detailed investigation into individual cases. It is, however, rather difficult to say how great the losses are in a larger district following infestation by this and several other oil fruit parasites. D r e e s (3) mentions damages amounting to 70—80 %. Similar figures are quoted by U n - t e r s t e n h ö f e r (30) in his paper on the effect of "E 605" when used to control pollen beetles. He arrived at yields which increased from 750 to 2,000 and 2,400 kg per hectare as a result of the control, in other words the pollen beetle was responsible for losses amounting to 62—70 %. Intensive pest control was nowhere so profitable as on rape and turnip. In cases where the harvest is less than 1,000 kg/hectare plus the high costs for fertilizers, seed etc., the cultivation costs are hardly covered. There are only very few of our own yield assessments available as obtained from tests carried out on rape. They always indicated considerable yield increases, but cannot be applied generally due to the low figure. We would mention two examples: in demonstration tests, the pods which fell off as a result of damage caused by the pollen beetle were counted with the following results:

Test in Vilmar
on "treated" 9.7 %

on "untreated" 40 %

Test in Schupbach
on "treated" 18 %

on "untreated" 35 %

17 and 35 % losses were avoided in each case by carrying out a single dusting. If the second dusting, which actually was really necessary but not applied for various reasons, had been carried out, the success would have been considerably greater (Photo 3).



Photo 3. Damage caused by pollen beetle. Bottom right: chewed and fallen off buds. Left: good coverage following field dusting. Centre: Condition of crop taken from untreated field section.

According to information supplied by the Hess. Statistisches Amt, the yields have increased from year to year (see Table 5). This may be chiefly due to the improved fertilization of the fields. But particularly in the case of this culture, pest control has become rapidly popular, so that a considerable influence on the increase of the yields is to be assumed.

Table 5: Average hectare yields of rape and turnip in Hesse (in 100 kg)

	1949	1950	1951
Winter rape	17.8	16.3	19.0
Winter turnips	11.7	11.2	12.6

According to the above-mentioned figures (Drees, Unterstenhöfer), a loss of 70 % in grain yield is to be expected when no control is carried out. When we take only the highly probable average yield of 2,000 kg/hectare (winter rape and winter turnip) into consideration, we arrive at a loss of 1,600 metric tons or DM 1,280,000 on a cultivation area of 1,138 hectares (at DM 80 per 100 kg). As we shall see later, controls on a much larger scale are already being carried out. Taking only the figures of Drees (3, pages 7/8) with a 25 % loss as a basis, likewise with a yield of 2,000 kg/hectare — we then arrive at the actual average value of 1951 — this would still mean a considerable drop in profit on a cultivation area of 1,138 hectares containing the above-mentioned oil fruits in the investigation area of 1950. The harvest decrease would then amount to 455 metric tons, which means a loss of approx. DM 360,000 at a price of DM 80 per 100 kg. This sum is a considerably weighty one when considering that the cultivation area is small. Also in this case the control costs of all areas are far less than the expected losses. An approximate expenditure of DM 90 per hectare may be anticipated when all areas are dusted twice. The amount to be spent is not even one third of the probable losses. The increase in average yields seems to justify the conclusion that in this case most damages were actually avoided by extensive control measures.

Reports made on infestation (see Table 4) show that even in this case the assumed losses of 25 % are not too high; in fact they may be too low. The pollen beetle was seldom missing; on the contrary heavy attacks (Figure 4) were frequently established. This signifies that hardly a single field was left undisturbed by this pest and the chewing activity was by no means slight despite extensive control measures.

4. Potato Diseases and Pests

There is no doubt that, among the agricultural cultures, the plant protection measures at present taken on potatoes are of the most far-reaching significance. In the foreground is the control of potato beetles (*Leptinotarsa decemlineata*), late blight (*Phytophthora infestans*) and degeneration diseases. All three exercise great influence on the amount of potatoes yielded. It is only with extreme difficulty that the individual influences can be separated. When carrying out tests to determine the reduction in yield it is nearly always customary to consider only one cause of damage so that the losses, caused by various diseases or pests, which are expressed by percentages cannot be added so easily. Firstly we shall examine separately the three main causes of damage with respect to their effect on the yields.

The potato beetle would certainly cause the heaviest damage if intensive control measures were not already being taken against it. The extent of these measures will be reported on later. It can only be stated at this point that there are no yield losses worth mentioning. Some indication as to how dangerous this pest could be is obtained from the yield results of individual fields which, for some reason or other, were not included in the general control action (Hanf, 10). In one case the harvest was reduced by 80 % because the plants had been chewed away, and in another case by 33 % (Photo 4).

If we were to allow the potato beetle complete freedom in its destructive activities, we would not be far wrong in anticipating 50 % yield losses. With 24,700 hectares of potato growing area, an average yield* of 20 metric tons and

* Note: Average of four years. The yields per hectare in Hesse were: 1948 = 17.86 metric tons; 1949 = 13.8 metric tons; 1950 = 24.68 metric tons; 1951 = 22.36 metric tons.

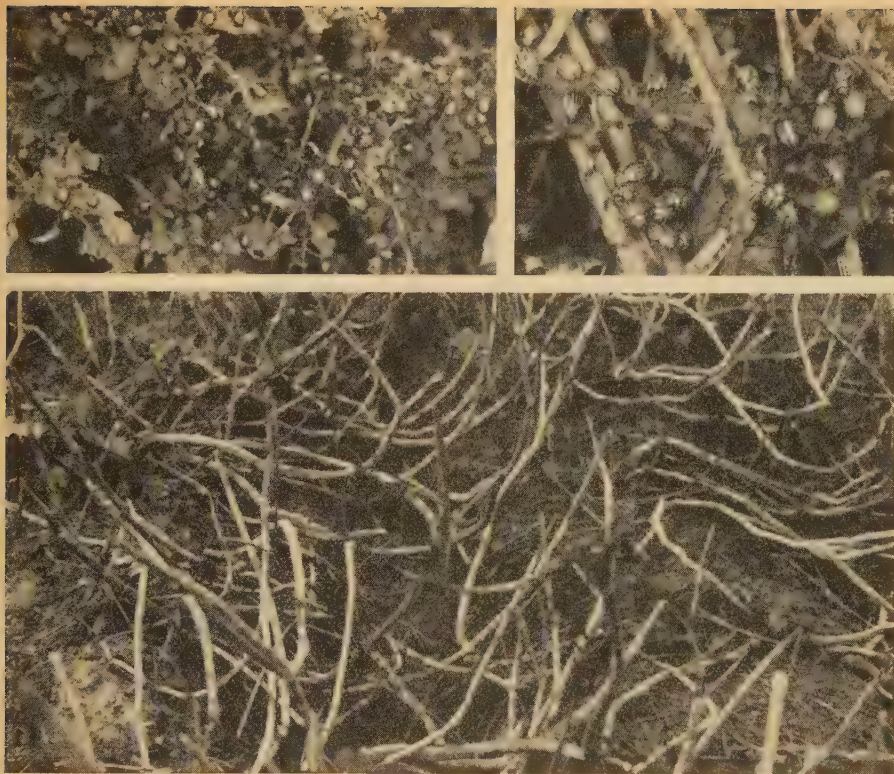


Photo 4. Damage caused by chewing activities of the potato beetle. Large numbers of young beetles completely devouring the foliage (top), leaving only bare stalks (bottom). This damage caused by chewing at the end of July led to a 40% reduction in yield.

DM 10 per kg., we have the enormous loss of DM 24.7 millions. Comprehensive controls are definitely worthwhile. The present extent of these controls will be referred to later on. We may well assume that hardly 1 % of the potatoes is destroyed by the potato beetle today, so that a maximum value of DM 500,000 is to be taken into account.

The necessity of late blight control has been repeatedly emphasized recently. Considerable sums of money have been spent by the State on demonstrations of control tactics in order to drive home to the farmers the advantages of control. In numerous tests the possible yield increases were ascertained and published. We would only give a few examples (Photo 5).

Ext reports an average yield increase of 4.4 metric tons per hectare for 34 field tests in 1939, namely 25 % of the total harvest (according to Rademacher, 25). Drees (4) reports, in connection with the results of the "Late Blight Control on Potatoes, 1950", on yield increases of 5 metric tons per hectare (Pflanzenschutzamt Kiel), 2.6 metric tons per hectare (Pflanzenschutzamt Hamburg) and up to 4.5 metric tons per hectare, an average of 1.9 metric tons per hectare, in South-West Germany. 20 tests we carried out showed the following results (Hanf, 12).



Photo 5. The *Phytophthora* destroys the leaves and thus damages the corms. Left: healthy leaves after spraying with fungicides. Right: dying plants.

Table 6: Results of late blight control, 1951

	Harvest in 100 kg/hectare		Yield increase in %
	sprayed	unsprayed	
Mittelfrühe Variety 7 tests	150—301	95—245	5—62
average	201	166	21.7 %
Bona Variety 7 tests	213—289	146—252	4—65
average	256	220	16.4 %
Ackersegen Variety 6 tests	157—325	135—263	3—45
average	224	185	21.1 %

An increase in yield of 3.7 metric tons per hectare, or an average of 19.7 % was obtained in this case. Of course the table also shows how large the differences are in yield increase (from 3—65 %). Similar results are also available elsewhere (e. g. Drees, 4 = 5—66.7 %). Here it is a question, however, of

registering the average values. According to the report by T a u b i t z (29), taken from a large number of tests (691), these amount to 17 % for Lower Saxony in 1950 and up to 28 % in 1949.

We may well draw the conclusion from the brief data available that we definitely have to reckon with regular harvest losses, caused by late blight, ranging from 15—25 % taken as an average over a number of years. Moreover it is to be considered that the evaluated tests reproduce with surety the actual conditions in an area, as the fields could not be selected beforehand according to the degree of infestation because the first spray, as we are fully aware, must be carried out before the *Phytophthora* appears on a large scale.

When assessing late blight damages it must be taken into account that this disease is considerably dependent upon the weather and does not appear to the same degree each year (see M a m m e n , 19, page 39: Abhängigkeit der Ernten vom *Phytophthora*-Auftreten [Dependence of the harvest on the appearance of *Phytophthora*] 1924—1928). However, the above values of at least 15 % loss are definitely justified as an average value. Taking the average harvest of the past four years, namely 20 metric tons per hectare, as a basis, under present conditions where there is still a complete lack of late blight control this would mean a loss of 75,000 metric tons or approximately DM 7.5 millions (DM 10 per 100 kg on an average over the past three years). Even in this case the control costs would again amount to only a fraction of the losses, namely about 1 million at DM 40 per hectare with two sprays.

The virus diseases play a very large part in the decrease of potato crops. As a direct control is not yet possible, the only way left open to prevent the harvest losses is to change the seed regularly, which means that approved, and to a large extent, virus-free plant potatoes should be used. It is a well-known fact that a yield decrease is to be expected when the seed is taken from non-cleaned stocks on one's own farm. This decrease amounts during the first year to about 15—20 % (R a d e m a c h e r , 24), and during the second year up to 50 % of a normal crop with virus-free plants.

The cultivation of approved seed potatoes is still on a very small scale in many parts of Hesse although this varies in the individual districts. According to the weekly agricultural paper for Hesse-Nassau (20), the following values are attained in the individual districts with respect to the annual change of seed potatoes:

Biedenkopf	11.1 % of the acreage
Schlüchtern	13.2 % " " "
Dillkreis	9.5 % " " "
Lauterbach	18.9 % " " "
Gelnhausen	20.6 % " " "
Wetzlar	21.1 % " " "
Alsfeld	9.7 % " " "
Oberlahn	17.2 % " " "
Giessen	33 % " " "
Büdingen	33 % " " "
Average	18.7 % of the acreage

We may therefore assume that the farmer only uses new seed every 3rd to 10th year, on the average every 5th year. Therefore only 20 % of the fields are planted with approved seed potatoes. That means we have to reckon with an average harvest loss of 25 to 30 % (D r e e s , 3) for the remainder. With an average crop of 20 metric tons per hectare on a potato growing area of 24,700

hectares (1950), a harvest of 494,000 metric tons is yielded. This consists of a full harvest on 20 % of the area and the harvest reduced by approximately 30 % on 80 % of the area. (The losses caused by late blight not to be taken into consideration.) The proportion is 26.3 : 18.4 metric tons per hectare. That means that some 8 metric tons more could be harvested on 19,760 hectares, in other words 158,000 metric tons or approximately DM 15 millions additional receipts.

The expenses for the approved seed as opposed to ordinary potatoes would amount to about DM 10 more for 2.5 metric tons per hectare, in other words DM 250. The expected increase in yield amounts, however, to 8 metric tons, namely DM 800 per hectare. Accordingly the increased investment is worthwhile in this case as well.

If we were to use only approved and perfectly healthy seed in the investigation area, DM 250 each would have to be spent for a further 19,760 hectares (= 80 % of 24,700 hectares of growing area) making a total of DM 4.9 million. That would amount to only one third of the losses. Such large quantities of approved seed might be difficult to obtain. It is sufficient, however, to change the seed every second year and not, as previously, every fifth year. We would then only have to reckon with losses amounting to DM 5 million for a 15 % yield decrease in the first year on 50 % of the potato fields. For that we could save about DM 3 million on extra expenditure for plant potatoes which would be deducted from the above-mentioned sum. The loss would then still amount to DM 2 million.

We see therefore, that, when considering the most important diseases and pests on potatoes, we have to expect considerable losses. We said that the potato beetle could destroy 50 % of the harvest, late blight 15—25 % and degeneration diseases 25—30 %. If all three were to occur together then we could expect no harvest whatsoever. It is not possible, however, to simply add three different factors together. In a field where the plants have been eaten bare very early on, neither late blight nor virus diseases could continue to have any effect. Potato leaves which have died off due to infestation by *Phytophthora* are no longer a source of nutrition for the potato beetle. It may, therefore, be presumed that only one of the three plant infestations has a full effect at one particular time. We should not be exaggerating, however, when we assume that the normal harvest could with surety be increased by 30 % by carrying out regular potato beetle control together with *Phytophthora* sprays and the planting of approved seeds on at least 50 % of the potato-growing area.

Late blight and degeneration diseases are distributed widely in the area. The lack of *Phytophthora* spraying and the small-scale application of virus-free seed are reflected even in this case in the reports of the investigators. Very heavy infestation (infestation number 5) is by no means a rare occurrence (see Table 7).

Table 7: Reports on the appearance of diseases on potatoes

District	Late blight			Degeneration diseases		
	1949	1950	1951	1949	1950	1951
1—4	1 3	2 4	1 4	2—5	2 4	2—4
5 8	1 4	2 5	2 5	3 5	2 3	2 4
9 and 10	1—4	2 5	1 4	3 5	2—5	2 4

5. Pest Control in Fruit Growing

It is hardly possible, chiefly because of the large fluctuations in yield due to other causes, to arrive at reasonably applicable figures concerning losses caused by diseases and pests. It is also not really worthwhile adding those results obtained from our own tests carried out in individual orchards as a new contribution to the abundance of similar tests, the results of which have already been published. The effect of correctly applied plant protection measures in fruit growing is sufficiently well known, but, as we shall see later, the application of this knowledge is still very limited. It is our intention, therefore, to limit ourselves to quoting only the average harvest results for Hesse during the past few years as given to us by the Hess. Statistisches Landesamt (see Table 8).

Table 8: Harvest of apples and damsons per tree in kg

	1948	1949	1950	1951
Apples	24.6	21.6	46.0	18.4
Damsons	26.2	7.8	32.6	13.6

These harvest results are calculated on the tree count of 1946 which we have since found to be approx. 50—60 % too low. It will have to be presumed therefore that the yields per tree are even lower. The total harvest on the other hand would remain the same in a larger area. We intend, however, to base our calculations on the statistical records, because there are no other valid figures yet available. It is very difficult to say to what extent the large fluctuations during the individual years may be attributed to parasitic infestation or weather influences. Well-cared for and regularly sprayed orchards in the investigation area, as opposed to the values given in Table 8, yielded fairly equal crops of between 60 and 80 kg per tree during the four years. These figures cannot be applied generally in view of the many various factors which play a part in farm fruit growing (Photo 6).

The average harvest of all varieties of fruit (chiefly apples and damsons) amounted to approx. 25 kg per tree during the past four years all over the area. At a price of DM 0.50 per kg this means a gross yield of DM 12.50 per tree or, for the complete area with 2.1 million trees (after deducting decaying trees), DM 26,250,000. As 50 Pfg. have, on the average, to be added as expenses for the dormant spraying per tree, the harvest will have to be increased by 1 kg in order to cover the expenses. It could be a very simple matter to obtain an increase in yield of 10 kg by carrying out regular and extensive dormant sprays (our own tests showed a 3—4 fold increase of the harvest).

It is not so much the quantity but the quality of the fruit which is influenced by summer spraying. These sprays (1 pre-blossom and 1—2 post-blossom sprays) were used almost exclusively for apples in the area. (The control of the plum sawfly on damsons etc. will not be dealt with in these considerations.) When taking the results of tests carried out in 1950 and 1951 in a 40 year old orchard

containing apple standards as a basis, we arrive at the differences subdivided into the individual quality classes as shown in Table 9.

The gross receipt per tree without the summer spray (dormant spray was carried out in each case, therefore no considerable difference in yield) amounted to between DM 30 and DM 40, and with a summer spray to approx. DM 50. There is a difference of DM 10 to DM 20 per tree, whereby it should



Photo 6. Pest control is not worthwhile on tree ruins of this type. Radical removal of decaying trees is the prerequisite for efficient fruit growing.

be considered that the complete orchard is in a very good condition, and it was only in that one particular year that the "untreated" check trees were not sprayed. Kotte (17) gives a particularly impressive example of what can be achieved by means of expedient pest control in fruit growing.

Each group of four apple trees yielded on the average

without pest control	12 kg
with pest control	176.5 kg

The pests and diseases therefore destroyed 93 % of the possible harvest. The difference would be even more striking if the subdivision of the harvest into the quality classes were to be taken into consideration (see Table 10).

Table 9: Results of summer sprays in Ortenberg (Kreis Büdingen)

		kg	Average crop per tree quality classes			Gross yield per tree in DM
			IA + A	B	C	
1950	Without summer spray* 8 trees	79.5	38.8 0/0	26.7 0/0	34.5 0/0	
			30.9 kg	21.2 kg	27.4 kg	40.45
	With summer spray 6 trees	80.0	72.4 0/0	22.9 0/0	4.7 0/0	
			57.9 kg	18.3 kg	3.8 kg	50.82
1951	Without summer spray* 11 trees	53.0	40.3 0/0	32.6 0/0	27.1 0/0	
			21.4 kg	17.3 kg	14.3 kg	27.92
	With summer spray 80 trees	71.2	86.1 0/0	8.6 0/0	5.3 0/0	
			61.4 kg	6.1 kg	3.7 kg	47.14
Eventual price per 50 kg in the individual quality classes:			DM 35	DM 25	DM 15	
* Each tree, however, was given a uniform dormant spray as well as thorough fertilization and proper pruning.						

Table 10:

	Quality classes				total
	Ia	A	B	C	
Without pest control	4 kg = 33%	1 kg = 9%	0 kg = 0%	7 kg = 58%	12 kg
With pest control	97 kg = 55%	53.5 kg = 30%	18.5 kg = 11%	7.5 kg = 4%	176.5 kg

When calculating the net proceeds for the quality classes Ia and A to be DM 35, B as DM 25 and C as DM 15 per 50 kgs., the following result is obtained for the gross yield per tree:

$$\left. \begin{array}{l} \text{without pest control} \\ \text{with pest control} \end{array} \right\} \begin{array}{l} \text{DM } 5.60 \\ \text{DM } 116.85 \end{array} \quad 1:20$$

The expenses for these six sprays could be assessed at DM 3 to DM 4. The value of the pest control on what are nothing more than completely neglected

trees appears particularly striking here. Unfortunately conditions of this description still prevail in most of the orchards situated in the local service district.

Taking the figures established above as a basis, there is a definite possibility of increasing the gross yield by 10 kg, in other words from 25 to 35 kg per tree; that means an increase of DM 10.5 million on 2.1 million trees (DM 25 per 50 kg). The further increase of the gross takings as a result of the summer spray (calculated only on 35 kg per tree) would again amount to approx. DM 5 if we take into consideration the following conditions of the quality classes (see Table 9).

	Quality classes			
	A	B	C	
without summer spray	40 %	30 %	30 %	= DM 18.20 per tree
with summer spray	80 %	15 %	5 %	= DM 22.76 per tree
price	DM 35	DM 25	DM 15	per 50 kg.

Calculated on the number of apple trees (approx. 750,000) this again amounts to DM 3.75 million.

6. Grain Weevil Control

Apart from the yield-decreasing activity of insects and fungi on the fields, the harvested stocks are also threatened by other pests. It is chiefly the grain weevil (*Calandra granaria*) together with several other loft inhabitants from the realm of insects which cause the most damage. It is very difficult to register the decrease in harvest and there are no precise data available on this point. Generally speaking, one reckons with a loss of approx. 10 % of the stored grain resulting from the activities of rodents and insects (see Richter, 26). From these 10 % we can at least put down the half, namely 5 %, to the account of the insects, in particular the grain weevil. Previous investigations had shown (see Hanf, 7) that on farms with an acreage of more than 2 hectares, approx. 750 kg of grain are stored on the average until the next harvest. Now that conditions have become more or less normal again, there will hardly be any change in the situation. In the investigation area we have approx. 40,000 farms of over 2 hectares. Approx. 40 % of these (Hanf, 7, page 61 and Table 11) are to be regarded as infested. We have therefore to contend with a quantity of grain amounting to 12,000 metric tons stored in these infested lofts. Based on a loss of 5 % this corresponds to a loss of 600 metric tons or DM 240,000. DM 3 to DM 4 will have to be spent on control agents per loft based on 50—60 sq. m., the average size of lofts in this area (taken from Hanf, 7 and reports on controls 1946/52). The proportion, loss : control costs, therefore amounts to DM 240,000 : 56,000. Even in this case the work is worthwhile. Determinations of the past two years have shown that the grain weevil is continually increasing in numbers and in certain districts it is already causing the millers great concern over the processing of delivered grain. This was confirmed to a large extent by the checks carried out again for the first time in 1952 (see Table 11).

On comparing the values in Table 11, it is recognized that the controls in one year (practically all infested lofts were also freed from vermin) make their effect felt the following year when the infestation decreases (see Dillkreis 1946/47, Giessen 1946/48, Wetzlar 1947/48).

Table 11: Estimated grain weevil infestation calculated from checks carried out in all lofts in numerous parishes

District	Year	checked lofts	number infested	% infested
Alsfeld	1939	3,896	2,318	59.4
	1940	6,222	955	15.4
Büdingen	1952	4,631	1,920	41.5
	1952	4,631	1,920	41.5
Dillkreis	1946	2,307	1,090	47.2
	1947	1,570	516	32.8
	1952	2,362	235	10.0
Giessen	1940	5,755	1,297	22.5
	1946	5,430	3,596	66.2
	1948	4,846	1,673	34.5
	1952	4,602	1,906	41.5
Oberlahn	1940	2,652	1,236	46.6
	1946	2,699	2,225	82.4
Wetzlar	1941	4,469	1,793	40.2
	1946	5,244	2,845	54.2
	1947	526	323	61.0
	1948	1,016	271	26.7
		58,227	24,199	41.5 %

7. Rodents

Field mice and rats, as the main vermin of this group responsible for causing damage, are also of particular significance. Whereas the rats are to be regarded as permanent pests both in the house and on the farm, plagues of mice mostly occur at regular intervals of 3 to 4 years. A timely control before the beginning of these years of infestation would help considerably to avoid losses which occur chiefly in clover and alfalfa fields. Mammen (19) has clearly shown the relationship between the appearance of field mice and the „winter killing“ of clover and alfalfa (see Fig. 7).

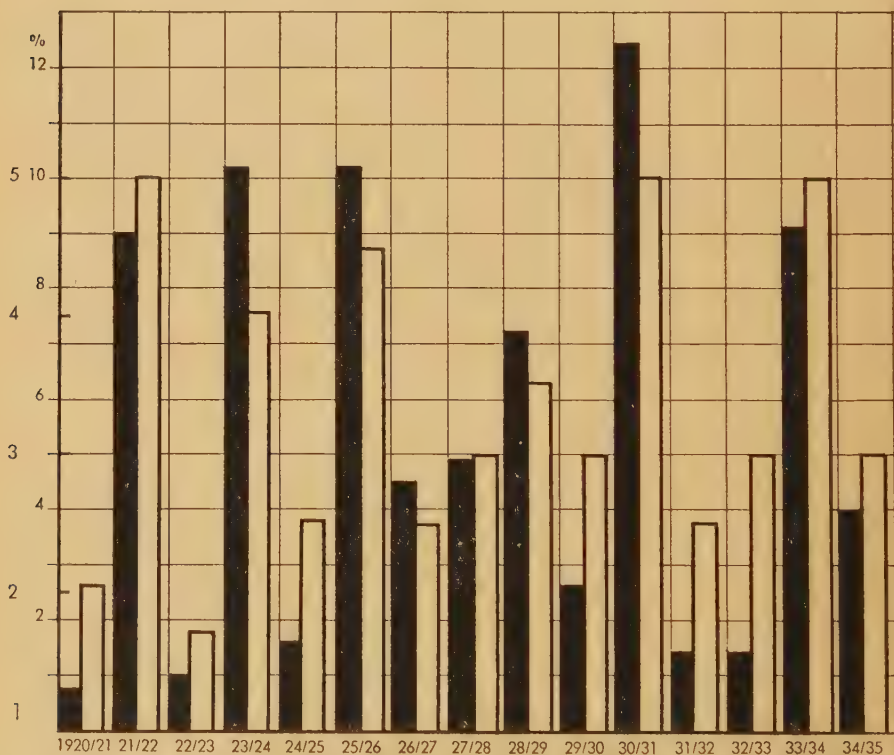


Fig. 7. Relationship between the appearance of field mice (white columns) and the winter killing of clover and alfalfa (black columns), degree of infestation in numerical values 1—5, damages to clover and alfalfa in percentage of the ploughed fields (according to Mammen).

Apart from the damage which they cause in winter to green fodder areas, the field mice frequently inflict considerable damage on grain. Numerous wheat fields were found in this district in 1949 which had been completely nibbled away by field mice. The haulms were bitten off at the bottom, then nibbled in pieces approx. 10 cm. long and finally the ears were crushed. Wood mice caused damage of a completely different nature (Photo 8). In the vicinity of hedges and the fringes of woods they nibbled the ears off upright rye haulms with the result



Photo 8. Damage inflicted by field mice and wood mice after feeding on the crops. Bottom: Section of a wheat field shortly before harvest, which was completely nibbled away by field mice. The haulms are chewed into small pieces. The control (see dead mouse in front of the hole) was carried out too late. Top: Practically every ear of a rye field has been nibbled away by wood mice from the standing haulms.

that the bare haulms were towering up above the undamaged ones which were leaning heavily under the burden of the ears.

It is hardly possible, however, to make an approximate estimate of the total damage. Calculated on the consumption of control agents (poisoned grain) the attack was very heavy, and in fact about 50 % of the grain, clover and alfalfa fields had to be treated. When assuming only 10 % damage on these 50 % (total losses occurred frequently), a yield loss of approx. DM 4.6 million results, while the costs for the control agent have only amounted to DM 80,000 in a year. When subdivided into 3 years, the damages therefore amount to DM 1.5 million.

The extent of rat infestation in individual areas has repeatedly been investigated. An attempt was also made to obtain data during the winter 1949/50 for 8 districts in the local service area. Questionnaires were sent to the burgomasters of all parishes to try and establish the degree of rat infestation, with the following results:

total number of parishes	= 628
number of parishes which reported	= 583
number of parishes reporting no rat infestation	= 217 = 35.4 %
number of parishes reporting 10 % of farms infested by rats	= 163 = 27.4 %
10—15 % of farms infested by rats	= 148)
more than 50 % of farms infested by rats	= 55) = 37.2 %

It is feared that the rat infestation is far heavier than was reported and apparently there is not a single place which is completely free of rats (Photo 9).



Photo 9. Breeding places for rats. Their removal makes the control easier.

It was reported that 13,000 farms are plagued by rats and it should be considered that the check was often only of a very superficial nature and consisted of putting simple questions to the house tenants. It is quite obvious that in many cases the tenants were reticent about disclosing the presence of rats, and when a report was made it was to be assumed that there was always a larger number of rats present. The animals hardly ever appear singly. If each farm were to have an average infestation of 20—30 animals, there would be about 325,000 rats making a nuisance of themselves. A rat consumes an annual quantity of nutrition corresponding to 18 kg of grain. This represents a loss of 5,850 metric tons on these 13,000 farms which in turn are only 16 % of all the farms in the area under investigation. According to Kemper, the food eaten by rats does not consist exclusively of high-quality nutrition, but 80 % of it is garbage which is unsuitable for human and animal consumption. However, even the remaining 20 % consumed by the rats represents DM 351,000 worth of damages, a figure which does not include losses caused by destruction, contamination and contagion.

The rat population of these 13,000 farms in the 8 districts reported as being infested could alone cause damage amounting to at least DM 500,000 annually. The application of extensive control measures would most definitely be worth while to eliminate this loss. An effective rat control would cost at the utmost DM 3 per farm, making a total of DM 39,000 at the outside for 13,000 infested farms. In other words the costs do not even amount to 10 % of the assumed losses.

8. Sum-total of damages

In the previous paragraphs an attempt has been made to illustrate the yield decreasing influence of a number of plant infestations which from an economical point of view are to be regarded as the most important and to compare these with the control costs which are actually necessary. At the same time it is clear that both values can be regarded only as approximate estimates and as such they have been repeatedly used as a basis in other districts and in the whole of the German Reich (see Mammen, 19, with literature references). A list of figures as far as they could be ascertained for the 10 most important control measures mentioned at the beginning is again given in Table 12.

The comparison of losses occurring at the present stage of the pest control and the costs of the necessary control measures appeared necessary in order to put those measures actually carried out into the right perspective. It will then become clear whether the present endeavours being made in agriculture to master the pests are suitable to considerably reduce the high losses or whether they are still insufficient. It must be emphasized that only a very small number of essential plant protection measures has been singled out in this paper and that the generally assumed total sum of 20 % yield losses is composed of many more individual damages although it is also calculated on the total value of harvest gathered from all fields (including vegetable fields, meadows etc.). It is worth mentioning that the calculated yield decreases, taken as a whole, are more or less of the same magnitude as those estimates previously available, namely 20 % (precisely 24.4 %).

On studying Table 12, we are struck by the great differences of the expected value decreases for the various diseases and pests. It is also shown, however, that we have to work with considerably large sums. The protection of a harvest valued at DM 170.2 million already justified extensive control measures being taken. The fact that the yields per hectare have been doubled during the course

Table 12:

Yield decrease caused by the most important

(= 10 rural districts with 784 peasant farms)

Details and Explanations

Diseases and Pest or Plant Protection Measures	Gross Yield Value of Most Important Cultures				
	Type	Acreage in hectares	Average harvest	Price in DM per 100 kg	Total gross yield in DM
1. Seed dressing	Grain	85,779	2,500 kg/ha	40	85,780,000
2. Weeds					
3. Pollen beetle	Winter rape and turnips	1,138	1,500 kg/ha	80	1,365,000
4. Potato beetle	Potato	24,700	20 metric tons/ha	10	49,400,000
5. Late blight in potatoes					
6. Potato degeneration diseases					
7. Winter spraying of fruit trees	Fruit trees total	2.1 mill. trees of all varieties	25 kg per tree	50	26,250,000
8. Summer spraying of fruit trees					
9. Grain weevil	Grain stocks				
10. Rodents	Grain and green fodder	Grain (see above) Clover and Alfalfa 15,404	6 metric tons/ha	8	7,394,000
Field mice					
Rats					
Totals:					170,189,000

uses and pests throughout the investigation area

53,000 hectares of arable land)

ct

Probable yield decreases at the time or increase possibilities			Costs of control measures on all areas		
Size	Monetary value	% of gross yield value	Monetary value	% of gross yield	% of losses
% of harvest	850,000	1	182,000	0.2	21.4
% of the fields 100 kg more	8,000,000	8	1,030,000 (spray with chemical agents)	1.2	12.9
% of harvest	340,000	25	100,000 (2 dustings)	7.3	29.4
% of harvest	(500,000)	1	600,000 (agent applied at the time)	1.2	12.0
% of all fields	(7,500,000)	15	1,000,000	2.0	13.3
% on 80% potato fields	(15,800,000) sum-total of all losses = 33% = 16,300,000	32	4,940,000 (increased price of DM 10 for plants)	10.0	32.4
possible yield decrease by 10 kg per tree	10,500,000	40	1,000,000	3.8	10.0
quality per tree (y apple) DM 5	3,750,000	14.3	1,500,000	5.7	40.0
% of grain lofts estimated 5% loss	240,000	2.8	56,000 (on 40% of lofts)	0.06	23.3
= 10% on 50% fields in 3 years per year	1,500,000	1.6	80,000 (in years of infestation)	0.08	5.3
10 farms attacked (% of buildings)	500,000	?	39,000 (on attacked farms)	?	7.8
	41,980,000	24.4	10,527,000	6.2	25.1

of the past century may be attributed chiefly to improvement in the varieties and the fertilization. However, within the bounds of plant cultivation as a whole, a good part may certainly be put down to the account of "plant hygiene" and "direct plant protection measures". For comprehensible reasons, only the latter can be included in the considerations under discussion in this paper.

When we carefully calculate the losses arising at present and then add them together, we find ourselves faced with a considerable sum, namely DM 42 million. This sum might just well represent production reserves, and as yet only few people have attempted to turn these losses to better purposes. Anyone thinking that this amount is too high should bear in mind that there are many more diseases and pests at work on the few cultures investigated. We would only remind you of rust and powdery mildew on grains, blight, black leg and *Rhizoctonia* on potatoes, cabbage seed stalk curculio, numerous fruit parasites, wilt of clover, wire-worms, white worms and many, many others.

Should the estimates actually be a few percent higher or lower, it is not really so important. The main purpose was to present the approximate magnitude of the damages and also to continue to point out that much could be avoided with little expenditure — compared with losses. The crops at present being harvested could be increased sevenfold, if the most important parasites were to be destroyed right down to the last field section. If only 6 % of the gross yield were to be spent on plant protection, we would be able to increase the harvest by one-fifth.

How do the individual measures taken in the local area appear in the sequence of their significance? (See Fig. 10.)

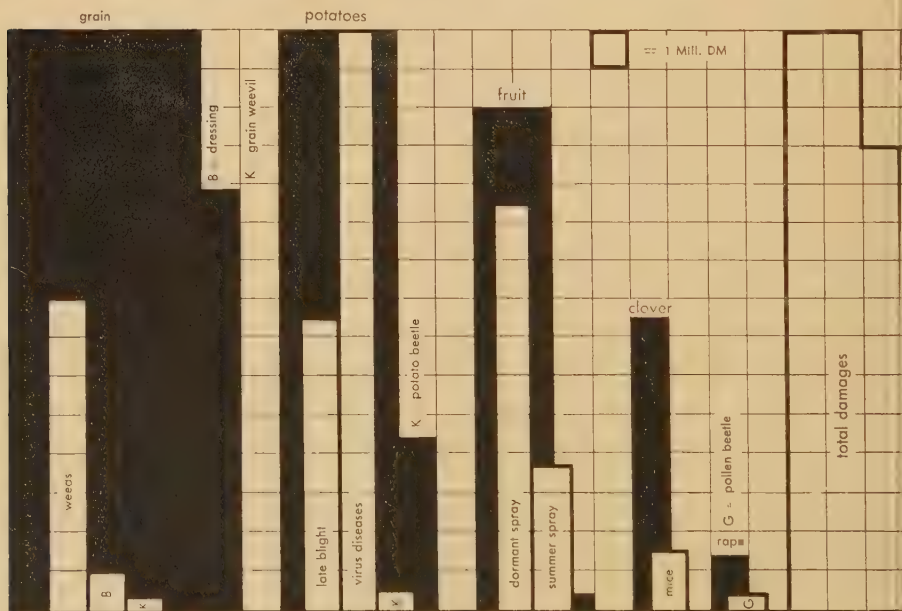


Fig. 10. Extent of the damages as compared to the gross yield value of the individual cultures (black columns show gross yield, white columns represent probable losses.).

Weed control in grain and the control of potato diseases are of the greatest importance to increase yields. When we place the 10 most important plant protection measures mentioned at the beginning and which at first were referred to in their approximate seasonal sequence, in a list according to their economical significance, we would obtain the following picture:

1. potato beetle
2. potato degeneration diseases
3. weeds in grain
4. *Phytophthora*
5. seed dressing
6. dormant spray of fruit trees
7. summer spray of fruit trees
8. rats and mice
9. pollen beetle
10. grain weevils.

This sequence does not necessarily apply to every single farm and every year. It may, however, be taken as a guiding principle for the importance of the individual plant infestations as yield decreasing factors of the total production in the whole area.

C. To what extent are the most urgent plant protection measures carried out?

1. Method of assessment

The assessment of the presumed yield decrease which is caused by the most important plant infestations has led to the conclusion that, on the 153,000 hectares of arable land in the investigation area, harvest assessed at a value of DM 42 million is destroyed by only a few pests and diseases. This means that the farmer sacrifices an income of DM 274 per hectare because plant protection has been exercised on such a small scale in the past. This figure seems to be unbelievably high; but can any serious objections be made to these loss figures? It is actually risky to draw conclusions on the yields of all fields in whole regions from the results of single tests carried out on proportionately small areas. Such inaccurate calculations may quite easily lead to false conclusions. Are not the harvest results of the lands und rural districts ascertained in the same manner? When single tests spread out over a large area repeatedly lead to similar results (see Weeds and *Phytophthora*) then a generalization can be well assumed with justification. Not included, however, are the differences between fields with and without good cultivation measures. The calculations always had to be based on the average harvest of the country. Deviations in the total loss amounting to many millions depending upon the assessed or estimated value are probable. Arguments may most certainly be raised over many of the quoted figures. In some cases the result would show an increase in losses whereas in others it would show a decrease. We cannot be completely certain about these points because, unfortunately, we still have not many exact yield assessments with and without pest control available, and in fact it will never be possible to produce such figures on a large scale.

An absolute exactitude of all numerical values is in fact not so important with respect to the investigations being dealt with in this paper. The main task

is to determine what action the farmer actually is taking in order to prevent the eventual losses. It is finally our intention to examine the proportion of the assumed damage to expenditure incurred for protective measures and, resulting from this, the possibilities of further increasing these protective measures. Should the difference between the two values be high then it does not really matter whether the figures on both sides are inaccurate to a few percent. If, on the other hand, this difference were to be slight, then the matter would become critical and it would be necessary to carry out more exact investigations of the individual districts. We shall see, to our regret, that this is not at all necessary and we shall have to be satisfied at present with a really rough survey.

This survey of the extent of individual plant protection measures could be obtained in various ways. Firstly a picture could be drawn by making inquiries at individual farms of varying sizes, and then to generalize. Another way would be to use the expenditure of farms keeping books as a basis. In this case, however, only the economically better situated farms could be included and it would never be possible to deal with the great mass of small farms. The third way would be to assess the consumption of pesticides in the area. This appears to us to be the best graduator for carrying out definite plant protection measures. An attempt was made therefore to obtain data as comprehensive as possible on this consumption question. Circular letters sent to all branches throughout the area which sell pesticides as well as to the central union of farmers brought about really useful results, although the data are to be treated with the necessary amount of caution. The sales figures provided by the farmers' union may be regarded as being completely reliable. These are available for the period from August 1948 to September 1951. Approximately 60 branches selling pesticides kindly provided us with detailed turnover figures. Single seed dealers, drug stores etc. have not provided any data. To an extent these are obviously inaccurate anyway. As, however, the turnover of plant protection agents sold by the union amounts to more than 80 % of the total turnover for most articles, a certain exactitude of the total result can be assumed also in this case. The sum-total of the data provided by the individual firms was increased by 50 % for each district in order to obtain a balance for those reports which were not submitted and to include purchases of firms situated outside the area (adjacent districts). It must therefore be assumed that the ascertained turnover figures reflect an approximate picture of the actual conditions. In addition, we would mention that, for obvious reasons, the turnovers of single firms are never given, but instead only the totals in the various districts or groups of districts.

Apart from the inquiries described, data were obtained on certain control measures by sending circular letters to the burgomasters (potato beetle, dormant spray) and from information provided by the agricultural schools (dressing weed control, late blight, grain weevil). In this way it was possible to compile the results for 1952 with respect to several controls. We would mention the method of assessment in the discussion on the individual measures.

2. Existing knowledge on the extent of plant protection measures

Many publications point out the necessity for an extension of plant protection. Everywhere it is emphasized that measures being taken at present are by no means sufficient to effectively prevent the threatening damage, but it is only in a few areas that investigations are being made into the actual extent of these measures, which is most considerable in special cultures (viniculture, hops, commercial fruit growing), whereas in the agricultural sectors very few

protective measures are taken at all. Rademacher has until now been the only person to arrange general investigations which he carried out in the Württemberg area. Inquiries were made at 115 farms to establish how many actually took definite plant protection measures (Rademacher, 24). The result of this is shown in the following list whereby we have only singled out those control measures being dealt with in this paper:

1. dressing of winter grain	at 94.8 % of the farms
2. potato beetle control	„ 94.8 % „ „ „
3. pollen beetle control	„ 80.9 % „ „ „
4. dressing of spring grain	
5. dormant spraying of fruit trees	„ 53.4 % „ „ „
6. grain weevil control	„ 42.6 % „ „ „
7. pre-blossom spraying of fruit trees	„ 19.5 % „ „ „
8. late blight control	„ 13.0 % „ „ „
9. post-blossom spraying of fruit trees	„ 2.4 % „ „ „

Hence there are altogether only three plant protection measures which are carried out at the majority of the farms used as a basis for the investigations. These are 1) dressing of winter grain, 2) potato beetle control and 3) pollen beetle control. About 50 % of the farm managers attach importance to spring grain dressing, the dormant spraying of fruit trees and grain weevil control. Further plant protection work is only observed by a small percentage.

No mention has yet been made of the percentage of area investigated. If the above figures were to be calculated on the corresponding areas of arable land then considerably lower values would be produced.

According to the investigations of Czech (2), the average amount of energy expended on plant protection measures at seven farms in Württemberg amounts to 0.40 % in the agricultural section, 3.22 % in field vegetable growing, 10.87 % in fruit growing and the remaining percentage for the corresponding cultivation branches. It is only in fruit growing that plant protection has developed into a considerable factor in economic management.

The book-keeping figures are available for 1948/49 from 256 farms in the Hessian area. The expenditure booked for pesticides amounts to DM 0 to DM 4 per hectare, an average of DM 1.10. Calculated on the expenditure for seed and fertilizers amounting to DM 122.50, the expenditure for pesticides amounts to 0.9 % of that spent on seed and fertilizers. Only 0.14 % of the established earnings are spent on plant protection agents, whereas 16.1 % are spent on seed and commercial fertilizers. As approx. 60 % of the costs for plant protection measures are incurred for the pesticides (see Hanf, 8, 11), this means that only 0.23 % of the farms' earnings are expended, as the total costs, for plant protection. It may be mentioned that these farms are to be regarded as progressive. The gross receipts from plant growing could have been increased 20 % through extensive plant protection. Actually this would also have required an expenditure of 6 % from the takings to be expected from plant growing, in other words a thirtyfold increase of the efforts. We therefore appear to be still a considerable distance away from reaching our ultimate aim, which is: "Prevent all yield losses caused by plant infestation". How do the conditions appear after comparing the turnover figures for pesticides with the expenditure actually necessary? Are there still such striking differences between the requirements for effective plant protection and the actual amount of work carried out? An attempt will be made in the following to reply to these questions.

It is intended to show in detail the sale of

dressing agents
weed killers
fungicides of every description
insecticides, both dust type as well as liquid;
the extent of dormant spraying
as well as rat and field mice control
and the grain weevil control.

3. Sale of seed dressers

It is a relatively simple matter to obtain data on the sale of dressing agents because nearly all dressing is carried out at the association's continuous dressing plants, and sales are also handled mostly by the union. Only very small quantities are sold on the market to private enterprises (10 to 20 % of the total quantity). It is not difficult to calculate from these data how much of the cereals could have been dressed. In the greater part it is a case of dry seed dressing. The calculations were based on a proportion of 200 g to 100 kg. The low consumption of dressing agents at the few existent quick wet seed dressing plants is more or less balanced by the fact that the extra quantity of dressing agent required for treating oats has not been included in the above proportion.

Unfortunately it was not possible to separate the dressing of winter und spring cereals since quantities bought during a certain period were not always used up at once but sometimes kept for application in the next season. A certain increase in dressing can be definitely recorded for the three years following the currency reform, at least in individual districts. In order to balance the overlapping of purchases of agents in the individual dressing campaigns, the quantities sold in Autumn 1948, Spring and Autumn 1949 and 1950 as well as in Spring 1951 were added together and the average for the three years was calculated. The average amount sown was 150 kg per hectare. In reality, however, the amount of seed sown is much larger in many cases so that the requirements for seed cereals may be even higher and the possible percentage of dressed cereals even lower (for details see Table 13). The districts of Schlüchtern and Gelnhausen are not included because the data from these districts were not complete.

Table 13 shows us that only a little more than half the seed grain is dressed. In one district it is only 30 % and the highest percentage is 71 %. We see that the necessity of applying this long known measure is still by no means recognized amongst all farmers. It must, however, be emphasized that there is no "seed dressing control", i. e. the supervision of commercial seed dressing, in Hesse as is customary in the other lands. An inspection of all commercial seed cleaning and dressing establishments started in the Spring of 1951 and continued in Autumn of the same year together with the distribution of many thousand copies of an instructional pamphlet already appears to have led to certain improvement.

Apart from the continuous seed dressing plants (Table 13), there is also a large number of seed dressing drums in use not covered by the investigation. It is an interesting fact that far more seed grain is cleaned than is dressed (see Fig. 11). Only about two-thirds of the seed are dressed after being cleaned and the chief reason for this is to save costs. This can be the only feasible explanation especially when it is considered that the seed had already been sent to the

cleaning plant and the use of the adjoining seed dressing plant would not have involved any extra work whatsoever. (In the comparison of cleaning and dressing the only plants considered were those with both continuous installations.) Fig. 11 furthermore shows that the quantity of spring grain dressed is 10 % less than the amount of winter grain dressed. According to the available data,

Table 13: Average sale of dressing agents per year (August 1948 to August 1951), grain growing area, seed and dressing agent requirements, actual dressing in % of the required seed cereals

District	Grain growing area (1950) in hectares	Requirements of seed (150 kg/ha) in 100 kg	Required dressing agent 200 g/100 kg in kg	Average amount of dressing agent sold in kg	Possible percentage of dressed cereals	No. of continuous cleaning and dressing plants	1 plant per hectare of corn
1. Biedenkopf	5,643	8,464.5	1,693	968	57	20	282
2. Dillkreis	4,208	6,312	1,262	527	42	15	280
3. Lauterbach	8,824	13,236	2,647	1,890	71	26	340
4. Wetzlar	9,480	14,220	2,844	867	30	19	500
5. Alsfeld	12,291	18,436.5	3,687	1,783	48	30	410
6. Oberlahn	7,566	11,349	2,270	839	37	28	270
7. Giessen	13,471	20,206.5	4,041	2,781	69	55	245
8. Büdingen	12,145	18,217.5	3,643	2,236	61	40	304
		—	22,087	11,891	53.8	—	—

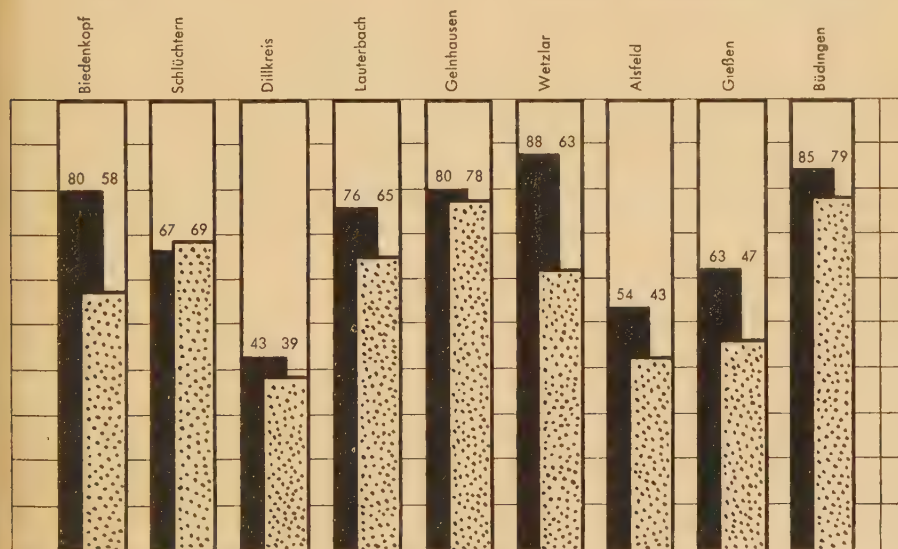


Fig. 11. Dressed corn as a percentage of quantities treated (= 100 at the continuous seed cleaning and dressing plants; black columns = winter cereals; dotted columns = spring cereals; figures = % of cleaned cereals).

which, however, are still incomplete, some two-thirds of the seed cereals are passing through the cleaning plants. The remainder is sown as it comes from the thresher, irrespective of seed cereals which are bought already treated.

The above-mentioned rates vary considerably. On the average a charge of 40—50 Pfg. per 50 kg. is made for cleaning and an additional 40—50 Pfg. for dressing. In many cases the charge for seed dressing is less than that for cleaning in order to encourage farmers to have their seed treated in both processes which generally costs DM 0.80 to DM 1. This is a modest sum compared with the other cultivation costs which, all in all, amount to several hundred marks per hectare. It was interesting to note that as the percentage of seed cereals dressed increases, the rates charged are correspondingly lower. This means that the more the plants are utilized, the more the expenditure incurred decreases.

A further reason why dressing is frequently not carried out is because the farmers fear the "toxicity" of any seed left over which can no longer be used as required.

In conclusion it may therefore be established that even in the energetic agricultural districts of the local service area, only about two-thirds of the seed cereals are dressed. With this, 75 % of the winter cereals and about 50 % of the spring cereals are treated. In some districts, however, not even a third of the seed requirement is treated. More intensified instructions are therefore necessary to achieve the aim "No seed cereals should be sown without first being dressed". The intensified appearance of stinking smut, loose smut in oats and leaf stripe will force many farmers to realize that it is worthwhile spending a few groschen on seed dressing. Without doubt, seed dressing was far more extensive before the war. The tendency — particularly on small farms — to save all expenditure and work which can be avoided is evident in this case. The danger which is thus related with this is mostly not recognized or else it is put down as being insignificant.

Table 14: Sale of Weed Killers (W = growth regulant)

District	Quantity of agents sold (according to information provided by the trade) in kg			Acreage of cereals in hectares (1950)	Quantities sold in hectares	
	1949	1950	1951		1949	1950
1—4	25 W	140.5 W	242 W 30 D	24,049	25	0
5—8	41 W 20 D	288.5 W 30 D	565 W 90 D	36,143	46	0
9 and 10	50 W	360 W 100 D	742 W	25,587	50	0
Sum-totals:	116 W 20 D	789 W 130 D	1,519 W 120 D	85,779	121	0
	136	919	1,669			

4. Sale of Weed Killers

As illustrated in Section B, 2, approximately 40 % of the grainfields are infested by weeds. According to this figure, no advantage was taken of the possibilities offered by the cultivation measures to control weed (e. g. harrowing and manuring with calcium cyanamide), or else these measures did not produce the desired success. The application of chemical weed killers based on dinitro-orthocresol or growth regulator (2,4 D etc.) would be necessary. Approximately 35,000 kg of such an agent with an average application of 1 kg per hectare would therefore have to be used. What is the actual position?

The necessary data on the sale of weed killers between 1949 and 1952 were provided by the trade itself and the agricultural schools (see Table 14). It will be seen from this table that 90 % of the agents sold were growth regulators and only a small percentage was yellow spray. The application of these weed killers increased tenfold in the course of three years, and in the fourth year (only data from the agricultural schools are available for 1952) it was forty times greater than in 1949. This success may be attributed above all to the following three points:

1. Intensified publicity by the plant protection service in the form of press notices and the publication of a leaflet whereby importance was chiefly attached to the yield reducing influence of the weeds.
2. Numerous control demonstrations by the plant protection service.
3. Intensified publicity by the industry since the introduction of the new growth regulators.

The data provided by the trade were supplemented by making enquiries at the agricultural schools. These estimates did not completely agree with the figures of the trade but they are always more or less in the same order of magni-

yellow spray) and treated cereal areas in ‰

Agent for . . . hectares				According to the information of the agricultural schools					
ha	‰	ha	‰	ha	‰	ha	‰	ha	‰
1950		1951		1950		1951		1952	
40.5	0.6	249.5	1.0	44.5	0.2	232.5	0.9	866.6	3.6
96	0.8	587.5	1.6	127	0.3	620	1.7	1,275.4	3.5
85	1.5	742	2.9	391	1.5	1,057	4.1	1,708.5	6.6
21.5	0.9	1,579	1.8	562.5	0.6	1,909.5	2.2	3,850.5	4.4

tude. The figures for 1950 are mostly lower whereas those for 1951 are higher. It therefore appears that several hundred kilogrammes were sold in 1950 which were not applied until 1951. The sum-totals of the last two years, namely

2400.5 kg sold by the trade

and 2472.0 kg as information supplied by the agricultural schools,

differ only by 3 %. These figures as a whole coincide with each other and it may be assumed that also the figures for 1952 fundamentally correspond to the facts.

What area of grainfields could be treated with the quantities sold? The possible area was ascertained by presuming an application of 1 kg of growth regulator and 4 kg of yellow spray per hectare. Experience in the field has taught us that in most cases farmers choose to apply larger quantities, and therefore the ascertained values would be too low rather than too high. The fortyfold increase in the sales of agents does not mean that it was possible to rid considerable cereal growing areas of weed. Only 10 % of the acreage of spring cereals could be treated in 1952. If the total area of grainfields, including winter cereals, is taken into consideration then the agents sold are only sufficient to treat 4.4 % of the fields. As 40 % of the grainfields show a medium to heavy infestation of weed, and on which a control would definitely have been financially advantageous, the results of our assessments imply that only few farmers have endeavoured to utilize the possibility of increasing the yields by about 600 kg per hectare and to rid the weed-infested fields of these troublesome parasites by applying chemical agents. The following picture is therefore presented:

- 56 % of the grainfields more or less free of weeds, presumably the result of cultivation measures (harrowing, calcium cyanamide etc.);
- 4 % free of weeds following chemical control;
- 40 % with medium to heavy weed infestation — without any control measures.

It is hoped that the rising tendency noticeable during the past four years to control weeds will be maintained in the future (see Fig. 12). If this were done agriculture could obtain some noteworthy results. Up to the present it would appear that it is only in the most energetic agricultural districts that weed control with chemical agents is of any real importance (practically 15 % of the spring cereal areas). The values obtained in the other districts are far lower. Anyway, narrow limits may be set to chemical weed control being carried out in hilly districts because of the difficulties encountered when using machines for this purpose.

We would, however, emphasize that there are also other methods to keep the fields free of weeds. Cultivation measures of a better and more general nature should, without doubt, be given more attention. In particular, the use of the harrow should be introduced on a wider scale to control weeds. Unfortunately this machine is to a large extent unknown on many small farms.

An interesting question is why so little use is made of the possibilities available for controlling weeds. The following reasons may be given for not doing so: 1) lack of time during the Spring months, 2) disinclination to incur extra costs for weed killers and 3) that to a large extent farmers are still ignorant of the mode of action and application possibilities of weed killers. It is surprising to note that in the same area there was a far greater demand by the consumer for "Weed killers containing chlorine for use on paths, lawns and sports grounds" ("Rasikal" etc.) (see Table 15).

Table 15: Consumption of Weed Killers containing chlorine for paths, lawns and sports grounds (in kg) compared with the agents used for arable land

	1949	1950.	1951
Agents for paths, lawns and sports grounds	1,557 kg	2,768 kg	6,463 kg
Agents for weeds on arable land	136 kg	919 kg	1,624 kg

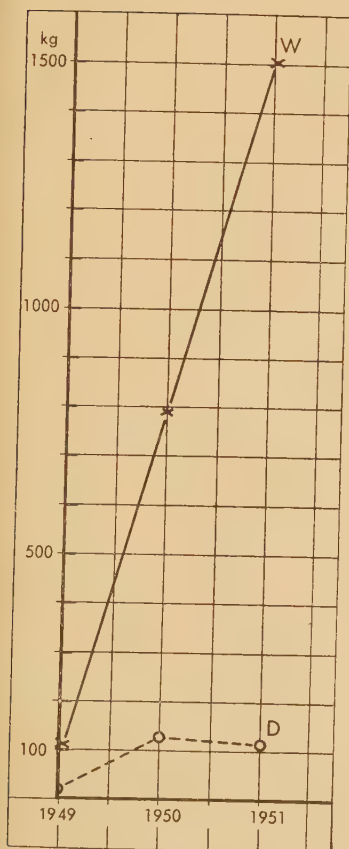


Fig. 12. Extent of sale of weed killers: W - growth regulator, D = agents containing dinitroresol.

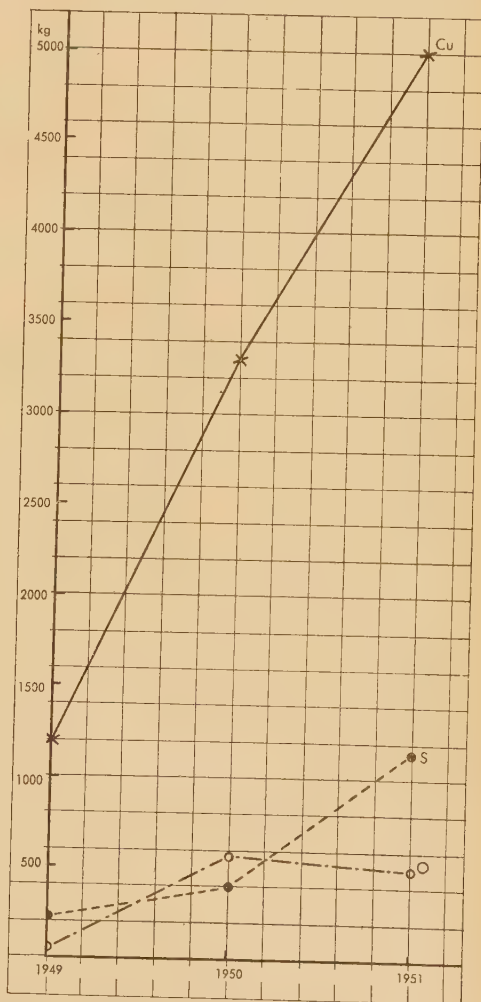


Fig. 13. Increase of the sale of fungicides from 1949 - 1951. Cu - copper agents, S = sulphur agents, O = organic compounds.

It appears that far more people know how to keep paths, lawns and sports grounds free of plants which spoil appearance although these plants do not reduce the quality of the ground. The circle of buyers may be said to consist more of garden owners in the town, who are apparently all for labour-saving methods, rather than farmers. Whereas approximately DM 25,000 were spent on agents to destroy weeds in grainfields in 1951 ($1544 \text{ hectares} \times 600 \text{ kg} = 926.4 \text{ metric tons} \times \text{DM } 40 = \text{DM } 370,560$) which meant an additional income of approximately DM 370,000, about DM 14,000 were spent in the same area to kill weeds on paths, lawns and sports grounds, chiefly for æsthetic reasons, to improve appearance and not to increase the yields.

5. Application of Fungicides

It is extremely difficult to record the use of fungicides and insecticides and, in fact, it is impossible to make a sub-division showing the application of these agents in the individual cultures when there is no way of assessing individually. The fungicides sold by the trade could have been used for blight control, spraying of scab in fruit growing, control of powdery mildew on vine varieties trained against house walls, control of diseases on vegetables and many others. We must therefore restrict ourselves to forming a conclusion on the possible treatment of various cultures from the sum-total of agents sold even at the risk of the same agent repeatedly occurring in our assessments. In doing so we shall deal only with late blight on potatoes and the spraying of apple trees against scab. In the case of the former it is our intention to investigate what areas could have been treated with all the copper preparations sold provided these preparations were used solely for this purpose. With respect to the extent of late blight spraying there are also estimates available which had been drawn up by the agricultural schools and which are to be used for the purpose of making comparisons. In the second case it is assumed that all the fungicides (with certain restrictions) had been used for two sprays against scab. It shall be established what percentage of the trees could have been treated in this way.

We would at first say a few words about the groups of agents chiefly sold in the area and the way in which the assessment was carried out. The most predominant of these are the copper agents with 15 to 18 % Cu content. Smaller quantities of copper preparations with a higher percentage of copper, above all "Cupravit" (Ob 21), were also sold. The best-seller among the sulphur agents is "Solbar" followed by small quantities of several wettable sulphur and colloidal sulphur preparations. In the case of the organic fungicides we are concerned

Table 16: Sale of Fungicides

District	1949			1950		
	Copper	Sulphur	Organic	Copper	Sulphur	Organic
1—4	75	15	20	256	105	185
5—8	238	0	0	1,022	114	231
9 and 10	864	211	31	2,027	175	144
Total	1,177	226	51	3,305	394	560
Sum-total		1,454			4,259	

with "Pomarsol" and such similar preparations. In order to calculate the possible quantities of spray wash, the following concentrations were taken as a basis:

- 1 % for Bordeaux mixture, "Solbar" etc.
- 0.5 % for organic fungicides and 45 % copper preparations
- 0.4 % for wettable sulphur
- 0.2 % for colloidal sulphur.

These average values show the quantities of spray wash to be prepared, and from the latter, conclusions can then be drawn as far as possible about the treated areas or number of trees.

As Table 16 shows, the sales vary considerably in the individual districts, although in these cases there has been an increasing tendency to apply these

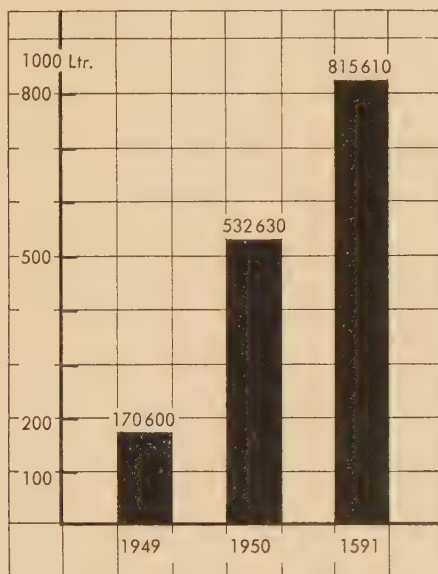


Fig. 14. Increase in the consumption of spray wash to control fungal diseases.

19-51 (in kg)

			Spray wash to be prepared (in litres)		
Copper	1951 Sulphur	Organic	1949	1950	1951
506	120	316	13,000	78,600	128,500
1,134	413	5	23,800	165,500	182,125
3,355	600	170	133,800	288,530	491,485
4,995	1,133 6,619	491	170,600	532,630	802,110

agents during the past three years (see Figs. 13 and 14). The amount of spray wash processed in 1951 was four to five times more than the 1949 quantity. A further increase may be observed for the copper agents used to control blight in 1952 (see below).

This increasing tendency, however, should not mislead us into presuming that everything is in order and that large areas have been sprayed. More than 800,000 litres — an enormous figure. But let us have a look what percentage of the acreage of potato fields could have been treated against *Phytophthora* with the copper agents sold by the trade. The corresponding values are entered in Table 17. On the average two sprays were assumed, which, as a rule, were actually applied. The few cases where a single treatment or even three and more treatments are applied can be regarded as being balanced by taking two sprays as a basis.

It can be recognized from the compilation that late blight control is still far from having been accepted by farmers in all areas. Once again it is the districts with somewhat larger farms, such as Büdingen and Giessen, where advantage has been taken of the possibility to increase yields by means of late blight control. In other areas, e. g. Hannover, already 33 % of the acreage of potato fields are said to have been treated. In our area the advantage of taking these measures has not been recognized at all.

When comparing the figures calculated from the sale of the agents with the 1951 estimates of the agricultural schools (Table 17), it is to be established that in most cases small areas have been quoted. This is understandable as certain quantities of copper agents were undoubtedly also used for single fruit tree sprays. Compared with the acreage, the error, however, is so insignificant (0.5 %) that we can actually speak of a useful conformity of the values. We can therefore state that on the average in 1951 not even 2 % of the acreage of potato fields were treated despite the fact that there was a heavy infestation of *Phytophthora* in 1950 and 1951. The interest shown by farmers for this measure was so minute or the ignorance of the effect of such a spray was so great, as the case may be, that out of approximately 3,000 kg of control agents provided free of charge in 1951 for the purpose of test demonstrations only 1,198 kg were used. This means that only about 100 hectares or 0.4 % of the acreage could have been treated. The additional work was regarded as being unbearable within the framework of the work to be carried out in agriculture during June and July. Nevertheless the intensified publicity, the impact of damages caused and the success-

Table 17: Possible Application of Copper Agents to Control *Phytophthora*

Districts	Acreage of potatoes 1950 in hectares	Spray wash in litres		Area (hectare) to be treated twice 600 litres per hectare		= % of the acreage of potatoes		Estimates of the agricultural schools	
		1950	1951	1950	1951	1950	1951	ha 1951	% of the acreage
1— 4	7,413	22,500	51,400	18.8	42.9	0.25	0.6	72	1
5— 8	10,398	102,200	134,400	80.2	111.9	0.8	1.1	67.5	0.6
9 and 10	7,795	200,500	357,500	167.1	298.0	2.2	3.8	210	2.7
	25,606	325,200	543,300	266.1	452.8	1.0	1.8	349.5	1.3
				Control demonstrations: approx. 100 hectares					0.4

ful results gained in the 1950 and 1951 tests which were repeatedly published and referred to in lectures have already produced very good results within a period of twelve months in this area. According to information supplied by the agricultural schools, 15,767 kg of copper agents were used in 1952 as compared with a consumption of 4,995 kg in 1951, in other words a threefold increase. As only one spray was applied in most cases during the dry year (generally together with the potato beetle control), 3,216 hectares are supposed to have been treated. No further sprays were carried out because of the dry weather and the resulting absence of *Phytophthora*. We must wait and see what the effect of experiences gained in 1952 will be on the further extension of late blight control.

As we have already mentioned, all copper preparations need not have been used to spray potatoes. This, in fact, is improbable. A proportion, just as in the case of the organic fungicides and most of the sulphur agents, will have been applied to control scab on apples. It is now our intention to elucidate the possible extent of this important cultivation measure in fruit growing. (According to our experience stone fruit are hardly ever sprayed in this area during the summer months.) A large proportion of the sulphur agents will also have been used to control powdery mildew on vines, because in many villages it often occurs that every house has its own vine. These suffered very heavily from *Peronospora* and *Oidium* during the past few years. How can we approximately determine what was undertaken to control this disease? It is only possible to make general estimates. We believe that we are not in error when we leave out the copper sulphide preparation (W 83) mostly used to spray vine and approximately 50 % of "Solbar" when calculating the possible fruit tree sprayings. The numbers of trees possibly sprayed given in Table 18 have, therefore, been calculated as follows:

It is assumed that the following was used for this plant protection measure:

all sulphur agents (except copper sulphide preparation and 50 % of "Solbar"),

all copper arsenic preparations (not taken into consideration for late blight),

for 1949 and 1950: half of the copper preparations,

for 1951: the copper agents after subtracting those quantities which, according to the estimates of the agricultural schools, were used against late blight,

and all organic fungicides.

Tableau 18: Possible Sprays of Apple Trees (15 litres per 2 sprays)

District	No. of apple trees	trees to be sprayed		
		1949	1950	1951
1-4 (5 incomplete)	237,000	650 = 0.3	3,585 = 1.5	6,280 = 2.6%
6-8	168,000	1,155 = 0.7	6,980 = 4.1	7,415 = 4.4%
9 and 10	344,000	4,960 = 1.4	11,730 = 3.4	13,200 = 3.8%
	749,000	6,765 = 0.9	22,295 = 3.0	26,895 = 3.6%

The quantities of spray wash to be prepared with all these agents were calculated. We assumed an average of 15 litres of wash for two sprays per tree, — as mostly old trees will have been treated — really the lowest limit.

Taking into account the limitations mentioned above, it would have been possible only in a few districts to apply a pre-blossom and post-blossom spray to several thousand trees with the fungicides released by the trade. The number of sprays carried out was most certainly not more than calculated but rather considerably less. It may, therefore, be established that in our area only 3—4 % at the utmost of the apple trees in farm fruit growing are given the most primitive of sprays to obtain reasonably clean fruit.

Even in our most intensive fruit growing districts in Rheingau and the Main-Taunus district, by no means all fruit trees receive sufficient summer sprays. According to the results of the inquiries so kindly placed at our disposal, the percentages of sprayed trees for 1949 and 1950 amounted to:

	Rheingau		Wiesbaden	
	1949	1950	1949	1950
Pre-blossom spray	31 %	30.2%	19.23%	9.54%
1st post-blossom spray	28.5%	36.4%	17.8 %	15.36%
2nd post-blossom spray	16.8%	22.4%	5.03%	5.33%

It is seen, therefore, that in Rheingau approximately one quarter of the fruit trees receive regular summer sprays whereas in Wiesbaden the number treated amounts to only one fifth to one sixth. These figures are in fact higher than those of Rademacher (24), who quotes 19.5 % for pre-blossom sprays and 2.4 % for post-blossom sprays in several districts of Württemberg.

It is therefore not surprising that it is still a rare occurrence when we produce high quality fruit in Germany (Fig. 15). The increasingly loud complaints about poor sales in years when there is a rich fruit harvest — such as in this area in 1950 — are unjustified as long as the fruit growers take no steps to produce perfectly healthy fruit. In 1950 high quality fruit found a good market at favourable prices.

According to the information given above the application of all kinds of fungicides is, therefore, still on a very small scale in the local area. What significance have 6.6 metric tons on an acreage of 153,000 hectares and 2.4 million fruit trees? A precise sub-division into all branches of application is naturally impossible. When we take *Phytophthora* and *Fusicladium* control, the main fields of application, we find — to give a general picture of the situation — that we cannot expect too many results considerably increasing the yield. 1 to 2 % of the acreage of potatoes or at the most 3 to 4 % of the apple trees could each be given two sprays. It is emphasized that these low percentages are apparently still too high because certain quantities of preparation should have appeared in both cases and that a separation of all agents for other measures was not possible. An enormous amount of work still has to be done until the losses, amounting to millions, caused by these two main diseases, are avoided.

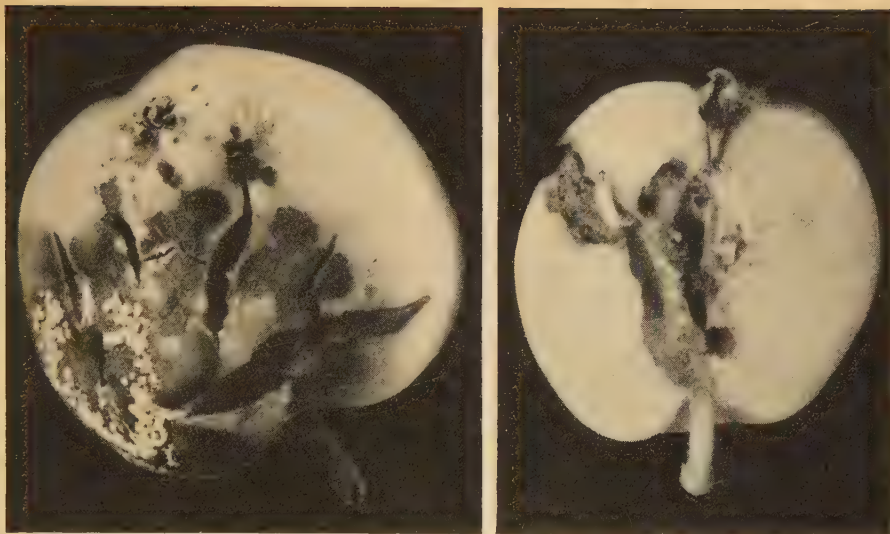


Photo 15. Scab (left) and codling moth (right) are chiefly responsible for harming the quality of the apples.

6. Application of Insecticides

The assessment of the use of insecticides turned out to be more complicated than for fungicides. The variety of the agents and of the possibilities of application makes it extremely difficult to form an analysis which somewhat corresponds to the situation. We shall therefore have to be satisfied also in this section with a discussion on the possibilities offered when taking certain measures. Without doubt the main field of application for insecticides is potato beetle control. The corresponding figures obtained from enquiries made by plant protection technicians and which are available from all districts can be accepted as being rather accurate since the greater part of the control agents applied was bought by the state and it is quite definite how this was distributed.

Next in importance is the control of the rape pests, particularly the pollen beetle. It is possible that the dusting agents not required for the potato beetle control have been used for the control of these pests.

Insecticidal sprays are used chiefly to control aphids on fruit trees and berry and currant bushes particularly in gardens, to control plum sawflies, and on occasions to control codling moth and apple blossom weevils. We shall have to be satisfied in determining how many trees could have been sprayed with the agents concerned. We are obliged to forgo a sub-division because there are no data available.

The potato beetle control will be dealt with in summary form because in this area the measures are directed according to the degree of infestation in such a way that in fact the greater part of the infested area is adequately treated. It was only occasionally that damage caused by chewing appeared on single fields. The reasons for this were mostly irresponsible carelessness on the part of the owners. The development of the potato beetle control during the course of the last four years is reproduced in Table 19.

Table 19: Consumption of Dust and Spray Agents to control potato beetles

		1949	1950	1951	1952
Acreage		24,090 ha	25,852 ha	24,707 ha	24,295 ha
area sprayed		5,502 ha = 22.8 %	13,906 ha = 53.7 %	9,047 ha = 36.6 %	13,363 ha = 56 %
area dusted		5,508 ha = 22.9 %	15,870 ha = 61.4 %	14,863 ha = 60.2 %	13,541 ha = 56 %
total area treated		45.7 %	115.1 %	96.6 %	111 %
spray agent made available	{ AS "DDT"	53.1 mt. t 45.7 mt. t	108.2 mt. t 3.9 mt. t	40.9 mt. t 8.6 mt. t	27.6 mt. t 7.2 mt. t
spray agent additionally bought by consumer	{ AS "DDT" Hexa	— —	19.6 mt. t 2.9 mt. t	— 0.6 mt. t	— 15.5 mt. t
dust agent made available		90.5 mt. t	174 mt. t	188 mt. t	10.9 mt. t
dust agent additionally bought by consumer		16 mt. t	114 mt. t	117 mt. t	244.6 mt. t

According to this, practically the whole of the potato acreage was treated at least once with insecticides during the last four years, and in fact certain sections were treated several times. This has proved to be the only plant protection measure applied more or less on a full scale. It also shows, however, what it is possible to achieve with suitable organisation and by making use of all competent authorities although even today the agricultural population of many districts is still opposed to taking comprehensive measures.

The total costs of the potato beetle control carried out in 1951 in the ten districts investigated amounted to (without equipment):

control agents purchased by the state	approx. DM 250,000
control agents additionally bought by the parishes and farmers	approx. DM 190,000
work carried out by the parishes and farmers (team costs and wages)	approx. DM 150,000
	approx. DM 590,000

Therefore an approximate total of DM 600,000 was spent in this case to avert any eventual damages (DM 24.30 per hectare). In addition there are the sums for the purchase of equipment, but these would have to be split up over a number of years and are also applicable to a number of cultures, and for this reason they are not to be taken into account at this point. Assuming a potato acreage of 24,700 hectares with an average harvest (1951) of 2.25 metric tons per hectare (according to the data of the Hess. Statist. Landesamt) and a price of DM 12, this would mean that a sum, corresponding to only 0.9 % of the total harvest, would have to be provided for the potato beetle control. If the potato beetles were to be allowed to carry out their ravages undisturbed,

the yields would soon drop by more than 50 %, as impressively shown by the individual observed fields damaged by chewing. The losses would therefore amount to fifty times, and more, the sums actually spent.

The total sale of dust agents is not inconsiderable, and among these the Hexa agents are by far the best sellers (see Table 20) (Fig. 16). The decrease in the sale of dust agents in 1951 may be attributed to the fact that large quantities purchased at the end of Summer, 1950 for the potato beetle control were not used and were therefore available for 1951, and furthermore not so much was used for the potato beetle control in 1951 due to a lower degree of propagation because of wet and cool weather conditions. If we subtract from the total sum those quantities used for the potato beetle control, an approximate picture is obtained showing what might have been available for other purposes. The following acreages of winter rape:

1949 —	178 %
1950 — approx.	271 %
1951 — approx.	55 %

for example, could have been dusted with these remaining quantities which, when summarized, amount to:

1949 —	40.4 metric tons
1949 —	62.1 metric tons
1951 —	12.6 metric tons.

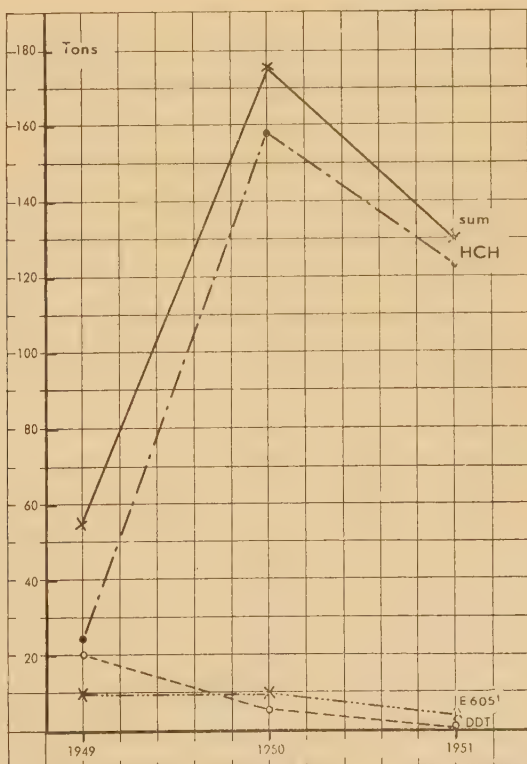


Fig. 16. Volume of sales of insecticidal dust agents. Decrease in 1951 caused by wet weather and the subsequent small-scale control of the potato beetle and other insects.

Table 20: Sale of insecti

District	1949				1950
	"DDT"	Hexa	E	Total	"DDT"
1—4	4,395	2,015	1,390	7,800	7
5—8	7,306	11,227	1,138	19,671	1,25
9 and 10	9,293	11,675	7,973	28,941	4,50
	20,994	24,917	10,501	56,412	5,83
bought additionally for potato beetle control — 16,000					
Remainder				40,412	
sufficient for				2.020 ha	
= . . . % of rape acreage				178 %	

It is difficult to say how much was actually used. Without any doubt however, the pollen beetle control has been boosted considerably since the war by the introduction of new contact insecticides. This boost was supported by the Plant Protection Office in the form of leaflet distribution — the leaflets were handed out to the farming population together with the food ration cards in 1947 and 1948 — by announcing the correct dusting dates and finally by the arrangement of demonstration tests. According to estimates of the agricultural schools and our own observations it may thus be expected that approximately 70—80 % of the rape and turnip fields are dusted at least once, but mostly twice (taking into consideration possible reserves from 1950, also probable for 1951).

The insecticidal sprays can also be used for the most varied purposes. We shall be satisfied in this paper by determining how many fruit trees could have been sprayed during the individual years and in the individual districts. In order to arrive at comparable values, the quantities of spray wash

Table 21: Consum

District	1949 agents sold in kg				Spray washes to be prepared	1950 agents sold in kg			
	Arsenic	"DDT"	Hexa	E		Arsenic	"DDT"	Hexa	
1—4	—	60	22	15.5	89,000	84	77.5	58.5	
5—8	—	50	97.5	30	140,500	--	52.5	159.5	
9 and 10	129	10.5	19.4	114.2	145,100	230	96.0	139.2	
	129	120.5	138.9	159.7	374,600	314	226.0	375.2	

ing agents (in kg)

1950			1951			
Hexa	E	Total	"DDT"	Hexa	E	Total
20,254	1,539	22,568	68	17,354	630	18,052
43,792	2,086	47,136	402	38,390	2,157	40,949
94,330	6,810	105,645	953	67,836	1,827	70,616
8,376	10,435	175,349	1,423	123,580	4,614	129,617
		— 113,200				— 117,000
		62,149				12,617
		3,107 ha				631 ha
		271 %				55 %

capable of being produced from the various preparations were calculated and compiled in Table 21. Those agents presumably used for the potato beetle sprays were subtracted beforehand. These are chiefly calcium arsenite and "DDT" agents sold in large quantities to one organisation and, as regards 1949, also certain Hexa agents.

As may be seen in Table 21, the number of trees which could be sprayed with the sprays that were sold was not very large. It is notable that the largest quantities of washes are tantamount to high sales of "E 605". It may be assumed with justification that just these quantities which the consumer obtained from the trade were by no means all used up or that the concentrations were assumed as being much higher than necessary (on the average a concentration of 0.02 % was assumed). The heavy decrease in 1951 may be attributed to the fact that in that year the fruit trees had a poor crop on them and therefore were hardly sprayed; even aphid control was not carried out in most cases.

insecticidal Sprays

S ay hes to epared	1951 agents sold in kg				Spray washes to be prepared	% of fruit trees that can be sprayed with the spray washes to be prepared (7 litres per tree for 1 spray)		
	Arsenic	“DDT”	Hexa	E		1949	1950	1951
6,625	6	55	1	1.5	21,850	1.9	2.7	0.5
7,200		47.5	73.5	5.75	61,500	2.8	3.3	1.2
0,800	350	174.75	38.0	26.70	268,950	2.8	5.5	5.2
4,625	356	277.25	112.5	33.95	352,300	2.6	4.0	2.4

For the possible use of insecticidal sprays main consideration is to be given to the control of plum sawflies on plums and damsons, aphids on all fruit trees, codling moth and various caterpillars. We should, therefore, calculate the possible consumption of spray washes on all fruit varieties. If we assume only one spray with seven litres per tree, the following could have been sprayed:

1949 = 54,000 fruit trees = 2.6 % of the stock

1950 = 84,000 fruit trees = 4 % of the stock

1951 = 50,000 fruit trees = 2.4 % of the stock.

The highest possible percentages would have to be listed with over 5 % in the districts of Giessen and Büdingen in 1950 and 1951. If it is considered that by no means all insecticidal sprays were used for fruit growing and that above all the E-agents and all "DDT" emulsions were used to control aphids in gardens and in market gardening, we must assume that only a very small percentage of the fruit trees could actually have been treated against such important parasites as aphids, codling moths and plum sawflies. Even in this case we are still a long way from producing high quality fruit on all the 2.4 million trees in the area.

7. Dormant Spraying

Very particular attention was paid all over the area to the dormant spraying of fruit trees because in this way a large number of important pests responsible for yield decreases can be eliminated from the outset. Aphids, leaf suckers, winter moths, bud moths, ermine moths and apple blossom weevils considerably influence the blossom and fruit production. The more blossom that is lost as a result of the activity of these pests the smaller will be the yield. Dormant spraying, therefore, is just as important as ever, all the more so in those areas where very little is still undertaken to control pests in fruit growing. Of course high quality fruit can only be obtained by carrying out the subsequent summer sprays (Photo 17).

The "regulation to control leaf suckers, aphids, scale insects and other fruit tree pests during hibernation" has rendered good service in this area. A regulation alone, however, can never lead to success unless appropriate guiding principles, supervision and permanent explanation put over verbally and in writing are arranged to enable the fruit growers to grasp the meaning of the regulation. The aim "Regular Spraying of all trees" is still far from having been achieved. The ups and downs in the sale of fruit are perceptible also in this area (Table 22). As sales were difficult and only possible at low prices following the rich fruit harvest in Autumn, 1950, many orchard proprietors did not spray in Winter 1950/51. Difficulties were experienced in the sale of the apples, however, only because they were mostly of a poor quality. The plant protection measures should, therefore, have been intensified in order to avoid these difficulties in future. A good market at favourable prices was also obtained this year for well tended apples. Following the very bad fruit harvest in 1951, there was again a considerably more frequent demand for intensified plant protection because it was hoped that this would lead to an increase in yields. The extent of dormant spraying accordingly assumed greater proportions again (see Table 22).

It is only in a few districts that more than half the trees are sprayed. On the average about 50 to 60 % were sprayed in 1949 and 1950 whereas in 1951 only 41 % were treated, not even half the stock. Despite "police regulations" and considerable publicity made verbally and in writing, it has not been possible to

Table 22: **Extent of Winter Spraying** (in % of the fruit trees according to data of the parishes)

District	% of trees sprayed			
	1948/49	1949/50	1950/51	1951/52
1. Biedenkopf	65.8	59	50.4	53
2. Schlüchtern	?	51	60	59
3. Dillkreis	30	37	41	?
4. Lauterbach	?	75	58	69
5. Gelnhausen	?	52	13.8*	21*
6. Wetzlar	40	44	16.5	59
7. Alsfeld	?	94?	45	74
8. Oberlahn	66.4	63	?	?
9. Giessen	63	63	45.3	56
10. Büdingen	?	70	37.6	66
Average:	53 %	61 %	41 %	55 %

* No regulation issued.



Photo 17a. The blossom production can be sensitively damaged when dormant spraying is not carried out. Aphids (left) and winter moths (right) destroy the opening buds.



Photo 17b. Even the fruit production is reduced when a late dormant spray is not applied. The apple blossom weevil destroys the flower.

convince growers that the dormant spray is the basis of all pest control in fruit growing. Moreover it should be considered that this control is not left only to the orchard proprietors, but is carried out almost everywhere by teams of sprayers from the parishes working on behalf of the burgomasters. If spraying were to be left to individuals, the position today would most certainly be the same as in 1938 before the above-mentioned regulation was issued. It may be said that at that time no more than 5 to 10 % of the fruit trees were given a dormant spray. Today the extent of spraying depends considerably upon the attitude of the burgomasters because they are responsible for carrying it out. This, therefore, is the reason that, out of 784 parishes in the area, no sprays were carried out at all in 327 parishes — in other words in 42 % — in the winter 1950/51. The percentage of sprayed trees would therefore increase to about 70 to 80 % for the remainder as compared with the average for the area of 41 %. The agents used were chiefly DNOC tar oils and, on a small scale, tar oils and yellow spray. However, dormant spraying is that measure in fruit growing which has been most widely introduced in agriculture.

8. Field Mouse Control

The interest in a field mouse control is completely dependent upon the appearance of this pest. It is well known that a mass propagation of the troublesome rodent occurs every three to four years. It would be best to carry out a control before this propagation commences which is indicated by a gradual increase in the number of mouse holes and the damage caused to clover and alfalfa in Winter. This control, however, rarely takes place. It is only when

heavy losses are suffered such as in this area in 1949 that hurried steps are taken to put right the work neglected (Fig. 18).

Fields completely nibbled away by mice were not a rarity in 1949. Many owners stretched wires with tins tied to them around the fields because they believed that only large animals could have caused such extensive damage. Very often they would not acknowledge that the small rodents were the evil-

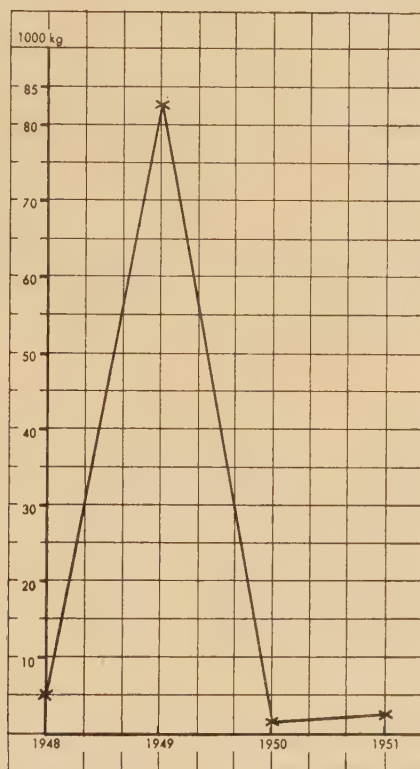


Fig. 18. Extent of the sale of poison grain to control mice. 1949 was a year with a very heavy infestation of field mice.

doers. It was not until the warm and dry summer months that they were taught otherwise by the ever increasing number of holes and the numerous animals scurrying around and gnawing away the crops, whereupon an extensive control was begun which involved the consumption of many thousand kilogrammes of poison grain (see Table 23). It is with justification that the saying "One learns from his mistakes" can again be applied in this case. But unfortunately this good sense did not seem to last very long because a mass propagation again appeared in the mild winter of 1951/52 and a "field mouse year" was expected in 1952. However, hardly any controls were carried out despite verbal and written directions.

We intend to correlate the quantities of poison grain applied in the single years with both the clover and alfalfa areas as well as the cereal areas. Taking

Table 23: Sale of Poison Grain to Control Field Mice

(Data in kg and hectares)

(% = possible treatment of the percentage of grain, clover and alfalfa areas)

District	1948		1949		1950		1951	
	Quantity	%	Quantity	%	Quantity	%	Quantity	%
1—4	820	—	10,142	—	672	—	904	—
5—8	1,092	—	31,104	—	424	—	1,030	—
9 and 10	3,447	—	41,185	—	518	—	513	—
	5,359	3.4	82,431	47.3	1,614	0.9	2,447	1.3

2 kg. of poison grain per hectare (figure arrived at following experiences in numerous controls) the following could be treated:

1948 — 3.4 % of the area

1949 — 47.3 % of the area

1950 — 0.9 % of the area

1951 — 1.3 % of the area.

We therefore have very large differences. The enormous increase in 1949 (see also Fig. 8) would really not have been necessary if controls had been made in good time. We see, therefore, that steps are taken when the damage becomes conspicuous, but then it is often too late.

9. Storage Pests

In conclusion we still have to mention the control of rats and grain weevils. Both pests are to be found everywhere but only very few house tenants take any action against these unwelcome visitors. It is only when united controls are organized that a larger participation and also success can be expected.

United controls against the grain weevil were last carried out in this area in 1948. In the districts treated in 1946 to 1948, it was established that an average of 55 % of the lofts were infested. Of these, 90 % were treated in the course of the centralized control actions, namely about 50 % of the total number of lofts. During the same period only 1.3 % of owners in districts working on a "Voluntary basis" rid their grain lofts of vermin. The same had already been established in previous control actions (1938—1941) (see H a n f 7). The increasing complaints of mill owners and dealers regarding the supply of infested grain made it necessary to carry out a renewed action in 1952.

Unfortunately there are no data available on the sale of grain weevil killers for 1949 to 1951. However, enquiries showed that only very few grain weevil controls were carried out. We are most certainly not mistaken in assuming the same number of "voluntary" controls as the previous years, namely 1 to 2 % of the grain storage rooms on farms. The reasons for this are due to the difficulty in carrying out sprays in cramped lofts. An increased control immediately began when extensive checks were organized in 1952 by the plant protection technicians and the local plant protection wardens. All infested lofts were

treated by the latter following a police regulation. Among 20,945 lofts which were checked it was ascertained that 6,841 were infested by grain weevils (= 32.5 %). The control was undertaken in practically every loft (99 %). At first energetic measures were, therefore, necessary in order to establish a general control against a widely propagated pest.

Even against rats which have spread quite considerably, it is seldom that any steps are undertaken. The so-called "rat days" — laying out of rat poison ordered by the authorities for every building — were by no means popular and were a source of constant annoyance to all participants. Rat control throughout the district was organized and carried out in only three districts during the last three years. Even in this case, the same attitude is encountered as in the field mouse control, namely control measures are not thought of until serious damage has been caused. Mostly the people concerned are satisfied with a single spreading of poison which often results in only slight successes.

As already explained in Section B, 7, some 13,000 farms out of 583 parishes were reported as rat-infested (= 16 % of all farms). Reports received dealing with control measures were very scanty and incomplete. All things considered, rat controls could only have been carried out in very few more than 1,000 buildings, that means in 8 to 10 % of the infested premises or, as for the grain weevil control, in 1 to 2 % of all premises. Once again only extensive organization can help to further improve the situation. And it is just this problem which is so difficult and far from having been solved.

D. Measures Taken to Protect Plants Can and Must be Increased Considerably.

The demand for an intensified application of plant protection measures is a matter of course for every specialist, although this cannot be said, unfortunately, for many practitioners. As a rule it was not necessary to continually reiterate the appeals for intensified control. We saw how much these utterances were identical for four decades. Is this a sign that no progress at all was made in plant protection? We know that this is by no means the case. But the claims and the necessity for more intensive protective measures increased, in fact to an even greater extent than the volume of the measures themselves.

We have considered ten of the plant protection measures appearing most urgent from the point of view of their economic significance (see Table 12). The calculated damage values were of a really varying nature both in their absolute amounts as well as in their relation to the gross yield value of the culture concerned. Agricultural losses totalling DM 42 million in ten rural districts — a rather large sum — naturally make it apparent that the application of plant protection measures must be considerably increased. This is an indisputable matter and requires no further discussion.

But can we considerably increase the application of these measures? Nobody would seriously doubt even this. But it is worth examining which plant protection measures are today carried out on a large scale and what are the reasons for this. Perhaps conclusions can be drawn from this how other plant protection measures, which are still not so "popular", could also be introduced on a wider basis. We therefore intend, first of all, to compare our determinations on the present extent of the most urgent plant protection measures (Table 24).

Only very little work is carried out today on such a large scale that a satisfactory reduction of the pests can be expected. At the top of the list is

the potato beetle control, a measure which, for about 15 years, was arranged by legal "coercion" and introduced and promoted everywhere by the establishment of the "potato beetle control service". Damages are almost completely avoided by the expenditure of considerable funds, but these funds may often even exceed the present losses in yield caused by pests (see Fig. 19). Without these state funds a much different picture would certainly be presented. We see a parallel in the control of the *Piesma quadrata* in Eastern and Central Germany in 1936 to 1939 which was also carried out on a large scale. The pollen beetle control likewise seems to be carried out on a satisfactory scale. Seed dressing and the dormant spraying of fruit trees cover only the half of the cultures affected. From the values given in Table 24 no correlations whatsoever can be established between the effect of damages and the application of control on the one hand and the effect of damages and costs on the other. These factors should have no particular influence.

When we classify the individual measures according to the extent of their application, the following picture is produced:

	Data of Rademacher	
	Own findings	for Württemberg
Potato beetle control	95—100 %	94.8 %
Pollen beetle control	70—80 %	80.9 %
Seed dressing	53.8 %	71.9 %
Winter spraying of fruit trees	40—60 %	53.4 %
Control of virus diseases on potatoes	20 %	?
Field mouse control	1—50 %	?
Weed control in cereals by means of chemicals agents	4.4 %	?
Summer spraying of fruit trees	2—4 %	19.4 % (pre-blossom) 2.4 % (post-blossom)
Late blight in potatoes	2—5 %	13.0 %
Grain weevil control	{ 1—2 % 99 % *)	42.6 %

*) 1952 with police regulation.

The plant protection measures mostly carried out in Hesse and Württemberg practically coincide. In the case of the others the local conditions appear to play a special part.

Inquiries into the reasons whether the farmers are more or less in favour of this or the other participation in plant protection is not easily answered. There are measures which, on the basis of police regulations, all farmers are "forced" to carry out and others which are applied "voluntarily". One might be inclined to assume that the issue of a police regulation also leads to complete control of a parasite, but unfortunately this is by no means the case. It is only with respect to potato beetle control that this applied approximately 100 %, whereas dormant spraying on the basis of the regulation to control leaf suckers etc. is only carried out to half the extent. On the other hand there are no regulations existent in this area with regard to pollen beetle control and seed dressing, but nevertheless these are carried out on the same scale as the measures mentioned above. Therefore police regulations alone cannot be decisive, yet they have a certain and sometimes not inconsiderable influence, especially when we think of the grain weevil and rat control action for example.

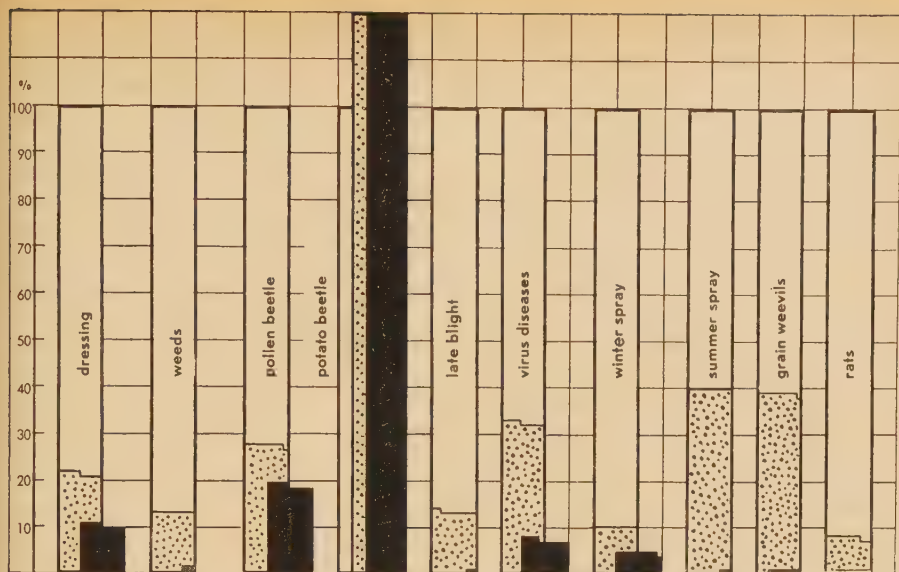


Fig. 19. Correlation between damages (expressed as 100, white columns), necessary expenditure to carry out full control on all cultivated areas (dotted) and present expenditure (black).

Without doubt the strict organization in this case had an influence on the extent of the work carried out. The control measures were carried out on all infested farms by outside labour often against the wishes of the owners. This "success" cannot be attributed to the population's willingness to attend to such matters.

On a closer examination of the dormant spraying of fruit trees and the field mouse control we find that there are considerable differences in the single years (see Tables 22 and 23). In the Winter of 1949/50, 61 % of the fruit trees were sprayed and only 41 % in 1950/51. The harvest of 1949 was poor in the local area whereas twelve months later it was a rich one. The feeling that something must be done to compensate for the damage caused by a lack of care and attention seems to have been prevalent in 1949 and again made itself noticeable following a very low yield from the harvest in 1951. It was the same in the case of the field mice. Serious damage was caused in 1949 with the result that there was an extensive application of poison grain which would have been sufficient for 47.3 % of the grain, clover and alfalfa areas. In other years the agents used amount to only a fraction.

Can it be said, however, that this determination is justified from a general point of view? We have in fact also found damages caused by other diseases and pests which are hardly observed at all, e.g. late blight, scab and weeds. Readiness to diminish the extent of damage can only be spoken of as long as the causes of this damage have been clearly recognized or as long as one knows what protective measures have to be taken. In addition to this there is the demand that the amount of work involved should be kept as low as possible. This point will be discussed later.

What is the actual position regarding the recognition of the causes of damage and the possibilities of taking protective mea-

Table 24:

The average application of the most urgent measures, as well as essential costs and

Diseases and pests or plant protection measures	<i>Present probable yield decreases or possibilities of increases</i>			<i>Possible measures, types of control</i>
	Extent	Monetary value	% of gross yield	
1. Grain dressing	1 % of harvest	850,000	1	Dressing of grain varieties
2. Weeds in cereals	on 40 % of the fields 20 %	8,000,000	8	Chemical weed control
3. Pollen beetle	25 % of harvest	360,000	25	Dusting with contact insecticides
4. Potato beetle	1 % of harvest	(500,000)	1	Spraying and dusting
5. Late blight of potatoes	15 % on all fields	(7,500,000)	15	Spray twice with Bordeaux mixture
6. Virus diseases in potatoes	on 80 % of the potato fields 30 %	(15,200,000)	71	Approved seed
	summary of all damages to potatoes 33 %	16,300,000		
7. Winter spraying of fruit trees	for possible yield increase by 10 kg per tree	10,500,000	40	Treatment of all trees
8. Summer spraying of fruit trees	better quality per tree (only apples DM 5)	3,750,000	14.3	Possible spraying with fungicides, twice (for apples): possible protection with insecticides, 1
9. Grain weevil	40 % of grain lots infested, 3 % loss	240,000	2.8	Treatment of lots
10. Field mice Rats	1949 = 10 % on 50 % of fields in 3 years, per year	1,500,000	1.6	Laying out of poison grain
	13,000 farms attacked	500,000	?	Lay out poison
		42,000,000	24.6	

Protection measures in comparison to the losses as
expended at present (Figures from 1951)

Percent of protection carried out on ...% of fields	Costs necessary to carry out control on all fields		Costs expended at present	
	DM	% of gross yield	DM	= % of losses
53.8	112,000	0.2	90,000	10.5
4.4	1,030,000	1.2	26,000	0.3
70—80	100,000	7.3	70,000	19.4
100	600,000	1.2	600,000	120
2—5	1,000,000	2.0	18,000	0.2
20	4,940,000	10	1,235,000	7.4
40—60	1,000,000	3.8	370,000	3.5
3.6 2.4	1,500,000	5.7	80,000	0.2
1—2 (52 : 99)	50,000	0.06	1,000	0.4
1—50 1—2	80,000 39,000	0.08 ?	various 3,000	0.6
	10,451,000	6.0	2,493,000	5.9

tures? With respect to the potato beetle it is a perfectly straightforward matter: the pest is conspicuous, the damage is considerable and distinctly visible when control is not carried out in good time, all sections of the population concerned with the cultivation of potatoes have been comprehensively instructed for years and years, and agents and equipment are provided to a certain extent. These are all factors which should lead to the promotion of a 100 % control. In spite of all this it was not until two years ago that a general treatment of all fields was attained in the local area after the propagation of the beetles and larvae and the extent of the chewing damage had increased, a state which had been reached several years earlier in South Hesse, a more favourable land from a climatic point of view. The pollen beetle is also distinctly visible and the damage which it causes is always considerable. Following the development of modern contact insecticides, the control of this parasite has been boosted considerably since 1946. Corresponding publicity (leaflets, newspaper articles) did the rest. Seed dressing is the oldest established control measure and during the past two decades it has been the most publicised. It receded during the course of time once it was seen that there was hardly any more damage. As soon as this damage apparently began to increase again it became necessary to start a new instruction campaign, and progress is once more already noticeable. The dormant spraying which was carried out before 1938 (issue of the regulation) on approximately 5—10 % of the fruit trees has been constantly publicised since then in lectures and instructional courses. Although it is difficult for the layman to recognize the pest stages to be controlled, 50 % of the trees are treated at the present time. Of course, the number would recede rapidly were it not for the "official coercion". This is to be attributed chiefly to the lack of private control equipment. There are, however, also numerous parishes where every year absolutely everything is sprayed and where the people are so convinced of the advantages of the sprays that they will never again cease applying them. In general it may be stated that the figure of about 50 % of the fruit trees does not originate from the fact that only a part of the owners in all parishes carry out spraying but that in one section of the parishes either everything or practically nothing is sprayed.

The farmer is fully aware that there are other pests and diseases but the extent of the resulting damage is underestimated. Belonging to this group are, inter alia, virus diseases in potatoes, weeds, grain weevils, rats and mice. On the other hand it may be said that the causes of late blight in potatoes is by no means perfectly clear to everybody. It is known that in one year the wort dies off earlier than in other years, and when it does so it is mostly in wet years. One also sees that the harvest can be smaller. "Of course, that is due to the unfavourable weather which we cannot do anything about", many people will say. The damages are therefore accepted because the farmer is anyway accustomed to fluctuations in the harvest yields. The connections between weather and *Phytophthora* fungus and thus the control possibilities are, to a considerable extent, unknown. It will not be possible to achieve any progress in the control of late blight until this obscurity has been remedied. Also in this case we would mention that the matter very quickly becomes a spreading topic of conversation and before long more fields are treated. The demonstration controls have brought about considerable progress.

A wide-scale introduction of other control measures is inhibited due to the difficulties arising from their application. Included amongst these measures are the summer sprayings of fruit trees in areas where the trees are situated in scattered strips on fields and meadows as this only creates considerable

difficulties especially when it is considered that the farmer dislikes taking the spray machine among the cultures growing underneath the trees. The latter are more important than clean fruit because one has not yet recognized the value of really high quality fruit which is often higher than the value of field crops growing below the fruit trees.

Of particular interest is the examination of the question whether the agricultural structure of an area has any effect on the extent of certain plant protection measures. On perusing through Table 25 in which all the tasks carried out individually are compiled, we are actually able to obtain a few clues. As mentioned in Section B, the last mentioned districts (9 and 10) are to be termed as "better" from an agricultural point of view (see also Table 1). The extent of practically all control measures taken in arable farming is, in this case, already above the average. These measures are carried out here on a much larger scale than on the small holdings run by the farmers' families in the hilly districts. In the case of the fruit tree sprayings the conditions are not quite so clear. Considering the small general scope of the sprayings only a few large commercial fruit growing establishments govern to a large extent the amount of the percentage calculated. The more or less good organization in the individual districts, in particular, is reflected in the winter spraying (see also Table 22). Generally speaking, the increase of practically all plant protection measures has become evident during the last three years (see also Fig. 20); likewise a certain influence of the agricultural structure. The more favourable this is and the more intensive the management is, the more will be the work done in this sector of plant cultivation. However, "the amount of work done" is still rather moderate.

A further very important factor with an inhibiting effect is the working time. It is just among the small farms, managed only by the farmers and the families without the help of hired hands, prevalent in this area that any additional work is avoided as far as possible. Because the tasks to be carried out in plant protection are still unknown, the burden of work thus involved is often overestimated to a great extent. The "time" factor for our ten plant protection measures has already been investigated at another location (Hanf 8) on a farm with 7.5 hectares of arable land. It was shown that too great an "unbearable" expenditure of time should never be taken as the reason for not carrying out a plant protection measure. Based on three permanently employed farm labourers working 25 days a month and 10 hours a day, 750 working hours per month are therefore available. From this total working period the following hours should be expended on plant protection:

Month	Hours to be put in by male workers	Hours worked by teams
January	0	0
February	2.5 = 0.3 %	0
March	7 = 0.9 %	1 = 0.4 %
April	6 = 0.8 %	2 = 0.8 %
May	11 = 1.5 %	4.5 = 1.8 %
June	24.5 = 3.3 %	0
July	6.5 = 0.9 %	4 = 2 %
August	0	0
September	2.5 = 0.3 %	0
October	0	0
November	5 = 0.7 %	0
December	3 = 0.4 %	0

Table 25: Application of several plant protection measures in various areas
(Data expressed in percentages of the acreages or fruit trees)

District	Seed dressing	Weed control			Potato beetle control			Late blight control	
		1949	1950	1951	1949	1950	1951	1950	1951
1—4	60	0.2	1.3	2.3	19.5	70.5	78.0	0.3	0.6
5—8	38.5	0.3	1.8	3.7	45.0	108.5	98.3	0.3	1.1
9 and 10	66.4	0.4	3.4	6.6	71.4	171.0	118.5	2.2	3.8
Average:	53.8	0.3	2.2	4.1	45.7	115.1	96.6	1.0	1.8

Spraying of Fruit Trees

District	Dormant spraying		Summer sprayings					
			Apples with fungicides			All fruit trees with insecticides		
	1950	1951	1949	1950	1951	1949	1950	1951
1—4	55.5	52.4	0.3	1.5	2.6	1.9	2.7	0.5
5—8	63.2	27.7	0.7	4.1	4.4	2.8	3.3	1.2
9 and 10	66.5	41.5	1.4	3.4	3.8	2.8	5.5	5.2
Average:	61	41	0.4	3.0	3.6	2.6	4.0	2.4

The great amount of work which has to be carried out in June is due to the control of diseases and pests in potatoes, including the selection of seed potatoes, when it is assumed that it has to be carried out on all fields which will only very seldom be the case. All the tasks can be fitted in without any difficulties between the peak periods of arable farming thus enabling this trivial burden, which mostly does not even amount to 1 %, to be borne quite easily. It is only important that all the tasks should be taken into consideration beforehand when the working plan is drawn up and not, as unfortunately has often been the case in the past, fitted in at short notice mostly when it is already too late. This harmonious inclusion of plant protection as an essential and indispensable cultivation measure in the total cycle of work involved for tending a certain plant variety appears to us to be the most important. In order to achieve this, the whole economic advisory service, particularly the science of husbandry, must come to the aid of the plant protection service.

The extent to which the "time" factor is decisive for the individual farms can also be seen from the fact that those plant protection measures which are carried out on a joint basis head the list. These are included in potato beetle

control, seed dressing (continuous plants), dormant spraying, to a large extent pollen beetle control and field mouse control during those years when the field mice inflict damage to the crops. Spraying of the fields against weeds and late blight has also been undertaken already by several efficient plant protection wardens in whole parish areas. The influence of such organizations on the extent of grain weevil and rat control has already been mentioned above. The employment of efficient plant protection wardens who carry out joint controls on all the fields involved with the little equipment belonging either to the association or to the parish is regarded by us as a means to the speedy fulfilment of the aim in the case of small farms and on those estates which have been split up on a large scale as a result of inheritance.

Endeavours have been made during the last three years to have a plant protection warden on call in every parish, but as yet this has not been accomplished everywhere. However, in the majority of villages such a person is appointed by the parish for training in regular courses so that he is prepared at all times to carry out good and extensive work. Once we have succeeded in having plant protection wardens in all villages who are able to demonstrate plant protection measures and to give advice to those farmers who are still lacking in knowledge on these matters, we should very soon experience a boosting of plant protection which will then lead to a marked decrease in damages.

Furthermore it appears essential to bring about a change in the mental attitude of the agricultural population to plant protection. Plant protection, due to the fact that it was not known of formerly, is regarded by many of the above as being superfluous and unimportant. It was only unknown, however, for the simple reason that the causes of many types of damage had not been established at the time. Everybody who is fully conversant with plant protection knows how many new things occur daily and how difficult it is to maintain sufficient command even as a specialist. How much more difficult must this be for those not in direct contact with plant protection. This does not only apply to the practical farmer but also, unfortunately, to a section of the advisory personnel who — and this may be said quite openly — sometimes “are not quite able to keep up with the progress being made”. At the time of their training several decades ago there was hardly any mention made of plant protection (even today there are still many universities without their own academic chair for phytopathology). The speed at which the other work is carried out simply does not leave the time to be up to date with work on all special fields in the same manner so that really no reproach can be made. The plant protection service, however, requires the assistance of the whole economic advisory service if we are to succeed in completely fitting the plant protection measures into the cycle of work on every farm.

It will be a difficult and slow process to change the attitude of farmers towards plant protection. It is shown again and again in field work that the young population is far more receptive to these questions. Therefore the machinery should be set in motion in the schools, elementary as well as technical, in order to awaken the understanding for the necessity of plant protection from the very beginning (see Heller 15, Leib 18, Neeb 22, 23).

After all that has been said, it can be established that we are still far from being able to effectively decrease the damages being caused to the agricultural cultivation plants. That means we would be in a position to do this if the whole section of the population concerned with the cultivation of plants were to fully cooperate and to follow the advice given by the plant protection service. This is still far from being the case as is once again clearly shown in summary form

by Fig. 19. The gap between expenditure which is really necessary, and which is mostly well below the value of the damages, and the present expenditure is still alarmingly great.

This gap, however, must be closed and it is the task of the plant protection service with its suggestions to achieve this. But are these suggestions not somewhat few and far between? One can hardly speak of an effective care of cultures when it is considered that in this area there is only one "plant doctor" for 75,000 hectares of arable land (including meadows, pastures and gardens) and one plant protection technician for 12,000 hectares.

The gloomy picture which has just been described brightens up, however, when in conclusion we consider the development of the sale of pesticides during the past few years. Taking the quantities sold in 1949 as a basis we arrive up to 1952 at the following:

- for weed killers, a fortyfold increase,
- for application of fungicides, an increase of four to fivefold,
- for the application of insecticides, an increase of two to threefold,
- for potato beetle control, an increase of two to threefold.

In the case of dormant spraying and field mice control there are, however, fluctuations due to prevailing conditions (see Fig. 20, only for 1949—51).

On the whole, however, a pleasing upward development can be established, a trend which ought to be increased. In order to achieve this, there are — to modify a well-known quotation — three points which are above all necessary: instructions, more instructions, and many more instructions. And that means instructions

1. to all authorities working in agriculture on the immense extent of the damages ((over DM 40 million in 10 districts alone),
2. to the agricultural population itself, concerning the sum and nature etc of these damages,
3. concerning the possibilities of diminishing these losses and
4. concerning the expenditures required and the profits to be gained as a result of these expenditures.

These are instructions which cannot just be given incidentally within the framework of the normal economic advisory service, but which demand a comprehensive extension of the plant protection organization, but to talk of this would not be within the scope and subject of this paper. This entails additional joint tasks for the plant protection offices with their branch offices, the plant protection technicians and above all the local plant protection wardens, which can only be mastered by a united organization.

E. Summary

There is no doubt whatsoever that the plant infestations caused considerable losses annually to agriculture and that these losses amount to approximately one fifth of the harvest yield. Protection against these damages has been demanded for five decades, and during this period the demands have remained more or less the same, although without doubt there has been a general progress in phytopathological knowledge and plant protection.

In an area comprising ten rural districts with 784 parishes and 153,000 hectares of arable land, an attempt was made to register the losses resulting from an unsatisfactory application of ten plant protection measures regarded here as being particularly important. These measures are: seed dressing, weed control, pollen beetle control, potato beetle control, control of late blight and virus diseases, dormant and summer spraying of fruit trees as well as the control of grain weevils and rodents (rats and field mice). The total losses were supposed

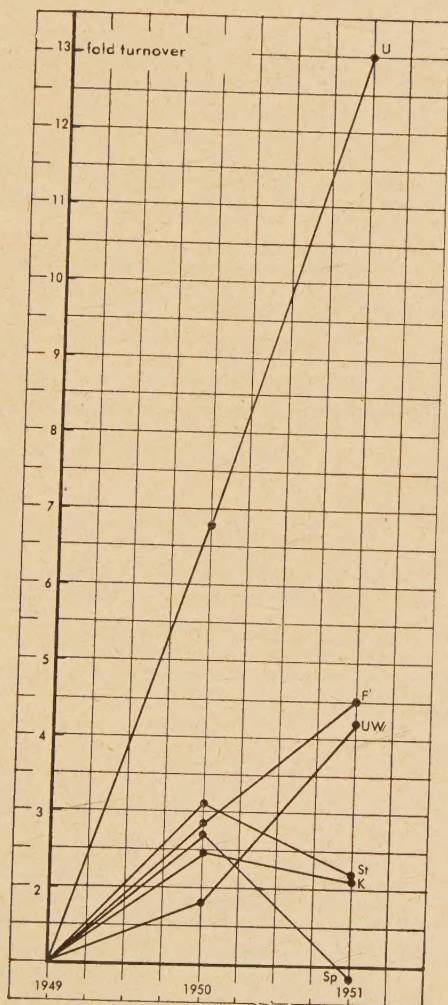


Fig. 20. Increase of sale of plant protection agents as compared to 1949. U = weed killers, UW = weed killers for paths etc., F = fungicides, St = insecticidal dusts, Sp = insecticidal sprays, K = potato beetle control. The decrease in the sales of insecticides in 1951 as compared to 1950 is due to the wet weather during the summer months and the almost complete lack of any fruit production, whereby any form of control was regarded as being not worth while.

to amount to DM 42,000,000 annually or 24.4 % of the grain yield of the cultivations concerned.

An attempt was made to register the extent of the control measures on the basis of the sales of plant protection agents as well as by making use of individual reports. It is shown that only the potato beetle control is carried out on a full scale, pollen beetle control only up to 80 %, seed dressing and winter spraying up to approx. 50 %. The extent of the remaining measures is so slight that an effect leading to a considerable increase in yield is not to be expected at present (see Table 24).

As compared with the expenditure of approx. DM 10 million annually required to treat all the fields under consideration, only DM 2.5 million are being spent, from which the main part (1.2 million) is spent to obtain approved seed potatoes (20 % of the total planting material).

On comparing the individual plant protection measures, it is shown that the ones mostly carried out are those which had been particularly organized and publicized as a joint control.

The main reasons for the small-scale application of most of the plant protection measures must be sought in the difficult working conditions on those estates which have been split up into small farms as a result of inheritance and in the lack of knowledge about the actual extent of the damages.

An extension of plant protection and thus an increase in yields may only be achieved by sufficiently instructing all participating circles on the actual losses and the possibilities of avoiding these losses by means of a well organized plant protection service and by engaging all branches of the general economic advisory service.

Although the investigations carried out here refer to a small area with a specifically agricultural structure, it may be assumed that the conditions — with variations corresponding to each individual agricultural culture — could also apply to other parts of the country, at least South West Germany. It is to be hoped, however, that the extent of all plant protection measures elsewhere would be far above the present extent established in this area. We fear, however, that this is not the case and that extensive work has still to be carried out everywhere by the plant protection service.

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